UNIVERSITY OF NATAL

PIETERMARITZBURG

SOUTH AFRICA

WATTLE RESEARCH INSTITUTE

South African Wattle Growers' Union — University of Natal —

Union Department of Forestry

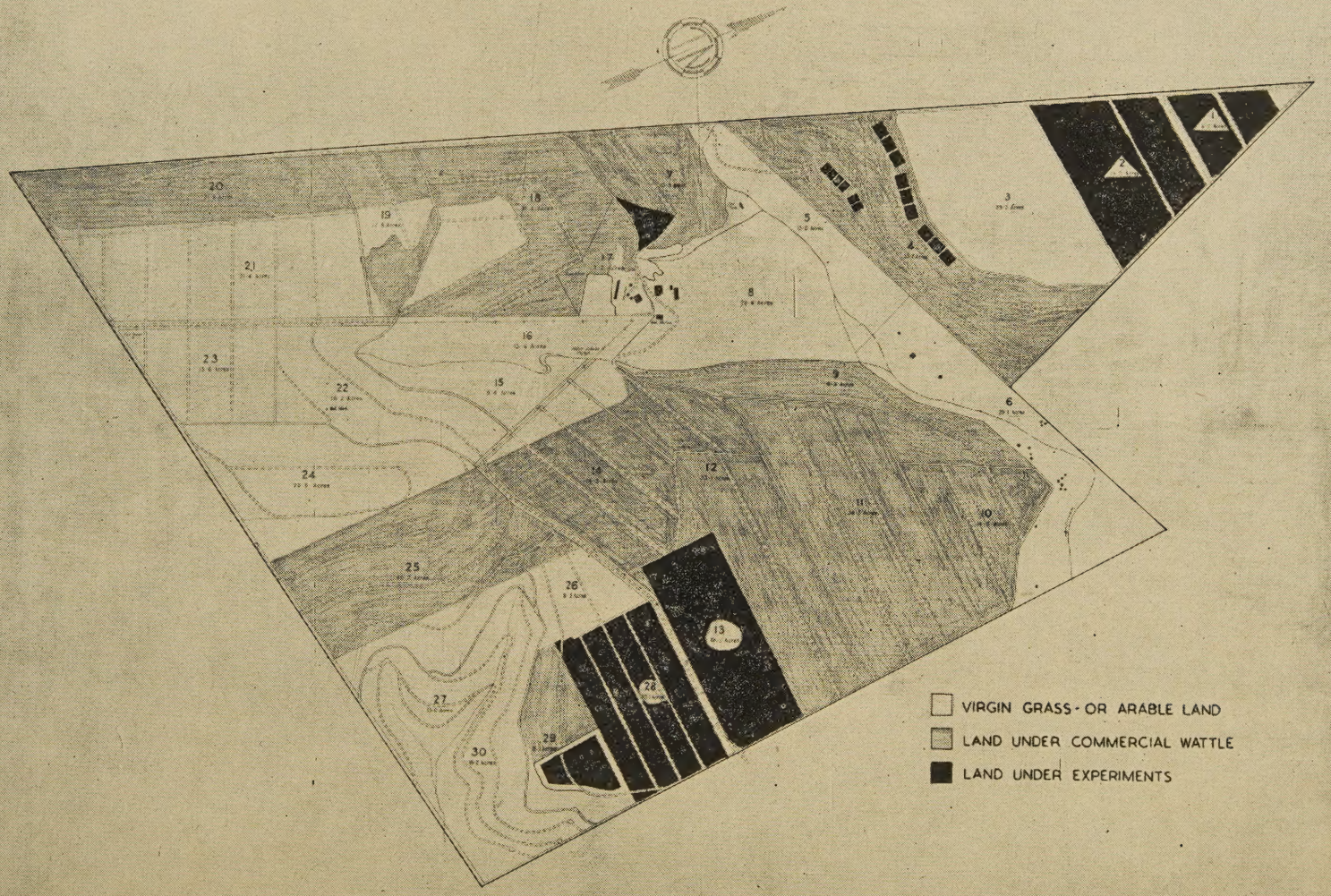
REPORT FOR 1951-1952

(FOURTH-FIFTH YEARS)

OCTOBER, 1952

South African Wattle Growers' Union - Farm Bloemendal

WATTLE RESEARCH INSTITUTE FIELD STATION



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COMMITTEE OF CONTROL OF THE INSTITUTE

Appointed by the South African Wattle Growers' Union (3) :

S. Clegg, Esq.

R. B. Fyfe, Esq.

D. R. Scott, Esq.

Appointed by the University of Natal (2) :

Professor A. J. W. Bayer, D.Sc. (*Appointed January,* 1951).

Principal E. G. Malherbe, M.A., Ph.D., LL.D. (*Chairman*).

Appointed by the Union Government Department of Forestry (1) :

H. B. Stephens, Esq., B.Sc., Dip. For. (*Resigned March,* 1951).

F. S. Laughton, Esq., B.Sc. (*Appointed April,* 1951, *resigned March,* 1952).

C. E. Lack, Esq., B.Sc. (*Appointed March,* 1952).

The Director :

Professor H. Shaw, M.Sc.Tech., Ph.D., F.R.I.C.

Honorary Secretary :

P. G. Leeb-du Toit, Esq., B.Com. (Registrar, University of Natal).

STAFF

(SEPTEMBER, 1952)

DIRECTOR :

H. Shaw, M.Sc.Tech., Ph.D. (Manc.), F.R.I.C.

Silviculture :

S. P. Sherry, M.A. (Oxon.), B.Sc. (South Africa).

Technical Assistants :

N. J. Cunningham (*Resigned May*, 1951).
M. J. Lourens.
P. D. G. Bullen (*Appointed June*, 1951, *resigned January*, 1952).
I. J. Meiklejohn (*Appointed February*, 1952).

Genetics and Plant Breeding :

A. A. Moffett, B.Sc. (Birm.), Ph.D. (Lond.).
Miss K. M. Nixon, B.Sc. Hons. (Natal).

Technical Assistants :

R. T. Brighton (*Resigned February*, 1952).
G. W. Adams (*Appointed February*, 1952).

Chemistry :

W. S. Martin, Ph.D., D.Sc. (Lond.), A.R.C.S., D.I.C., A.R.I.C.
C. G. Gordon-Gray, B.Sc. Hons. (Natal).

Entomology :

L. L. J. Ossowski, M.F., For. Ing., D.Sc. (Poznan).

Technical Assistant :

G. B. Wortmann (*Appointed May*, 1951).

Administration :

Miss E. K. Smith (*Appointed March*, 1951).

Non-European :

Seven.

Field Experiment Station Overseer (S.A.W.G.U.) :

M. A. Stewart.

FOREWORD

In previous years, the Annual Report of the Institute has been published in April, in anticipation of the South African Wattle Growers' Union Annual Congress in May, and has covered the calendar year to 31st December. Its belated appearance this year calls, therefore, for a word of explanation.

For some time past, a difficulty has been experienced in trying to summarize and report experimental work in progress at the height of the growing season. When, therefore, the Wattle Growers' Union changed its financial year, the Institute welcomed the opportunity to follow suit and adopt the year ending 31st August for both report and accounts. This has enabled work in progress to be reported up to a well-defined seasonal phase and has allowed the writing up to be done at a time of year when the demands of field work are least insistent.

The present report, in consequence, covers a period of twenty months from January, 1951, to August, 1952, inclusive. The accounts have been brought into line by introducing a short period of eight months from the 1st January to the 31st August, 1952.

The general plan of the Institute's work has now taken shape and the main lines of investigation are becoming more clearly defined. During the period under review, the farm "Bloemendal" has been extensively rehabilitated in course of fitting it for use as a Field Experiment Station and some eighty acres have now been planted to experiments. A plan of the farm appears as frontispiece to this Report.

Two developments in the Entomology Section, namely the institution of detailed records of the occurrence of wattle insects and the starting of a type collection, call particularly for the interest of growers, whose co-operation in the way indicated on page 17 is earnestly requested.

An innovation in this Report is the inclusion of a section devoted to Growers' Bulletins. It is hoped that these contributions, of a less technical and more directly advisory nature than the Research Reports, will prove to be of interest and value to growers in general.

H. SHAW, *Director.*

October, 1952.

BUILDINGS AND PLANTATIONS

Main Building.

During 1951, the first instalment of building renovations became necessary and at the end of the summer, the whole of the outside wood and metal work was cleaned and painted. A persistent and refractory trouble arising from cracks and water seepage in one corner of the building has not been remedied by superficial repairs and a more radical treatment may prove to be necessary. White ants have made their appearance at several points inside the building and some damage has already resulted. All available remedies are being applied.

The Insectary has been completed by bringing up to it a piped water supply.

A very desirable improvement has been effected at the rear of the building by asphalting the whole of the surface at a cost of £175 10s. 0d. This has put an end to the repeated washing and crumbling of the earth bank and has rendered the approach to the garages much easier for the Institute vehicles.

The approach tracks to the Institute remain in an unsatisfactory and sometimes even dangerous condition, though temporary improvements have been effected by scraping and grading with the help of the farm equipment. Inability to obtain soil nearby or at a reasonable cost has prevented any further development of the immediate surroundings of the building.

Nursery.

Permanent beds have been marked out and edged with bricks, with a consequent improvement in appearance. A small plantation of black wattle has been established to facilitate *ad hoc* tests of the effect of insecticides, weed control chemicals, and the like. These trees will shortly be replaced by a new crop so that young material will continually be available.

Field Experiment Station.

A road system, planned to serve all parts of the farm and comprising some twenty-two miles of roads, has been surveyed and demarcated, and approximately one-third has been completed under the supervision of the Farm Manager. Wherever possible, roads have been kept parallel to one another to permit the maximum number of rectangular plots to be laid out between them, but in no case has gradient been allowed to exceed 1 in 15. In addition, roads have been spaced to permit brushpiles to be shifted after each cycle, while providing at all times for two parallel rows of plots one chain in width between roads and ensuring that bark and timber need never be carried more than fifty yards to the nearest road. Improvements in the water supply have been planned to provide for nursery irrigation as well as to improve the domestic supply.

Meteorological equipment, comprising a daily rain gauge, maximum, minimum, grass minimum, and wet and dry bulb thermometers, and a sunshine recorder, has been

installed and daily records are being kept. It is proposed shortly to install a weekly rain gauge, about one mile away from the daily gauge and at a higher altitude, to determine whether there are major differences in rainfall over the farm as a whole. The lay-out and treatment of experimental areas on the farm are described in the Research section of this Report. The extension of these areas has meant a gradual reduction in the amount of land planted to agricultural crops and it is probable that these will soon be eliminated completely so that the land can be properly prepared for experimental use. Although the interests of the field experiments are paramount and, in consequence, many uneconomic procedures cannot be avoided, the farm continues to show a working profit, as is reflected in the accounts of the Wattle Growers' Union.

An aerial survey of the farm was completed early in 1952 and the resulting map, with the present allocation of land, is reproduced as frontispiece to this Report on a scale of 1 inch to 400 yards.

ADMINISTRATION AND FINANCE

There being no occasion for special meetings, the Committee of Control met for four ordinary meetings in 1951 and for three in the eight months to August, 1952. At the end of March, 1951, Mr. H. B. Stephens left the Committee on retiring from government service. He was one of the original members of the Committee, representing the Department of Forestry, and had rendered valuable service to the Institute throughout its existence. Mr. Stephens was replaced by Mr. F. S. Laughton, the new Conservator of Forests, who, in turn, on his transfer to Pretoria, was replaced by Mr. C. E. Lack in March, 1952. The Committee nominated Professor A. J. W. Bayer to replace Mr. Stephens as assessor member of the Wattle Growers' Union Field Experiment Station Committee.

The Director was absent overseas on long leave from late February to late July, 1952, during which period Dr. Moffett served as Acting Director.

The matter of a formal agreement between the three bodies interested in the Institute was further considered. The Government, through the Secretary for Education, Arts and Science, declared itself unable to enter into a formal contract and in these circumstances, a Memorandum of Agreement between the South African Wattle Growers' Union and the University of Natal was drawn up and signed in November, 1951. This served to remove the technical difficulties which had arisen from the absence of any formal agreement.

In the course of these negotiations, the matter of an increase in the Government grant in support of the Institute was raised and consideration of such an increase was promised in respect of the financial year 1952-3 and subsequent years. In the event, however, the Treasury declined to agree to an increase although the proposal had the support of the Department of Agriculture and the Department of Forestry.

The first award of a Wattle Research Institute Scholarship was made in January, 1952. The successful applicant was Mr. P. E. Metcalf, an honours graduate in Zoology of the University of Natal, who, with the approval of the Senate of the University, is working in the Entomology Section of the Institute for the M.Sc. degree on the subject "A Preliminary Study of the Bionomy of One or More Minor Wattle Pests."

Building Account.

Two small items only of additions to buildings have arisen during the period under review, namely the asphalting of the area enclosed by retaining walls at the rear of the Institute, costing £175 10s. 0d., and the laying on of water to the Insectary, costing £13 7s. 0d.

Research Account.

The total expenditure for the year 1951 was only slightly higher than that for 1950. Salaries were inevitably somewhat higher, but remained well below the estimate because projected appointments have not yet been made. On the other hand, travelling expenses were considerably reduced because no member of the staff went overseas on official business. Increasing costs of equipment and materials, where the charges for hide powder for analyses and for fertilizers and insecticides for field experiments are particularly heavy, prevented the reduction under this head that might otherwise

have been expected. The item of income for analytical services arises from analyses carried out for the Government Wattle Bark Inspector as a check against his grading.

Close comparisons are impossible for the eight months period to 31st August, 1952, since several major items of expenditure are segregated in one or another part of the full year. The biggest single item was £1,200 for the purchase of an additional motor vehicle, rendered necessary by the expanding field and advisory work of the Institute.

A new feature in the Balance Sheet for 1952 is the reduction made in the value of capital assets on account of depreciation. This has been done on a graduated scale ranging from 2½ per cent. in the case of buildings to 25 per cent. for motor vehicles.

The summarized statements of Expenditure and Income for 1951 and for the period 1st January to 31st August, 1952, appear below. Detailed accounts and Balance Sheets are published separately.

RESEARCH INSTITUTE ACCOUNTS

1st January, 1951, to 31st December, 1951

Expenditure	£	s.	d.	*Income*	£	s.	d.
Research and Administrative Staff Salaries, etc.	10,578	19	6	S.A.W.G.U. Grant ..	9,508	15	9
Travelling and Subsistence	702	19	6	Department of Forestry Grant	5,000	0	0
Laboratory and Office Equipment and Maintenance	2,183	1	5	Analytical Services ..	102	18	0
Library	188	1	2				
Printing and Stationery ..	197	10	10				
General Administration ..	585	11	4				
Building Addition (Tarmac)	175	10	0				
	£14,611	13	9		£14,611	13	9

1st January, 1952, to 31st August, 1952

Expenditure	£	s.	d.	*Income*	£	s.	d.
Research and Administrative Staff Salaries, etc.	7,653	16	10	S.A.W.G.U. Grant ..	8,214	2	9
Scholarship	120	0	0	Department of Forestry Grant	3,333	6	8
Travelling and Subsistence	611	7	10	Analytical Services ..	6	6	0
Laboratory and Office Equipment and Maintenance	1,345	2	10				
Motor Van	1,202	7	6				
Library	162	18	3				
Printing and Stationery ..	70	17	0				
General Administration ..	373	18	2				
Building Addition (Insectary)	13	7	0				
	£11,553	15	5		£11,553	15	5

STAFF

Despite repeated advertisement and the consideration of a fair number of applications, it has not yet been possible to fill the vacant senior post of plant physiologist. Enquiries over a wide field have revealed a general dearth of experienced scientists in this branch and many overseas institutes are experiencing precisely the same difficulty. Meantime, it is not possible to develop several important aspects of the Institute's work.

In August, 1951, Miss K. M. Nixon, an honours graduate in botany of the University of Natal, joined the Institute staff to assist in the work of the Genetics and Plant Breeding Section.

The normal development of the research programme and the rapid increase in advisory work, particularly in the Silviculture and Entomology Sections, has emphasized the need for additional junior research officers. A new post of Assistant Silviculturist has recently been approved and it is hoped to make an appointment in the near future.

There has been the usual disturbing turnover in assistant staff. Mr. N. J. Cunningham, who had been in the Silviculture Section of the Institute from its inception and before that was on the staff of the Research Department of the Wattle Growers' Union, resigned in May, 1951, to take up an appointment on a commercial fruit farm. From the Genetics Section, Miss I. A. Pedlar, appointed in August, 1949, resigned in February, 1951, on proceeding overseas and Mr. R. T. Brighton, appointed in February, 1950, left in February, 1952. Mr. P. D. G. Bullen was appointed to the Silviculture Section in June, 1951, but left in January, 1952. Mr. G. B. Wortmann was appointed to a new post in the Entomology Section in May, 1951, whilst Mr. G. W. Adams and Mr. I. J. Meiklejohn joined the Genetics Section and the Silviculture Section respectively in February, 1952. There still remains one vacancy in the last-named section. In January, 1952, Mr. M. J. Lourens, now the senior assistant in the Institute, was promoted to Technical Assistant, Grade III.

This high rate of wastage of junior assistants, often before their initial training can be considered complete, is no less of an embarrassment because it is a well-known and widely occurring phenomenon. In an attempt to remedy the position, improved conditions of service, particularly more rapid advancement to pensionable grade, are being introduced.

After a little over a year of highly efficient and most acceptable service as Secretary/Typist, Miss N. van Soelen resigned in February, 1951, in anticipation of her marriage. Fortunately, it was possible to appoint a successor, Miss E. K. Smith, to take over without a break.

Students from the Department of Zoology were again employed to assist in the seasonal work of the Entomology Section, mainly on wattle bagworm surveys. Messrs. J. Parkinson and C. Handley worked as temporary field assistants in the Silviculture Section during February, 1952, and May and June, 1952, respectively.

Dr. P. Deetlefs, of the Rhodesian Wattle Company, Limited, spent three months at the Institute for training prior to taking up his appointment as Estates Research Officer. Dr. Deetlefs worked for some time in each section, but devoted particular attention to silvicultural research methods and to protection against insect pests.

During the winter of 1952, Mr. S. P. Sherry, Head of the Silviculture Section, suffered a lengthy illness, but is now completely recovered.

ADVISORY WORK, COMMITTEES, CONFERENCES, ETC.

Advisory.

Advisory correspondence has continued to increase and 181 letters were written in 1951. The rate was still higher in 1952, when 141 replies were sent out in the first eight months. Nearly three-quarters of the enquiries came from Union sources, but no less than 65 letters were written to Southern Rhodesia, mainly in connection with operations to control an outbreak of chafer-beetles. The remaining enquiries came from Angola, Argentina, Australia, France, Great Britain, India, Kenya, Mexico, Northern Rhodesia, Swaziland, Tanganyika, and the United States of America. Insect problems and pest control have now become the chief subject of enquiry (138) though silviculture and allied problems also increased (103). Chief among other subjects were bark, extract, and factory problems (22), timber utilization (17), and chemical analysis, soils, and fertilizers (10).

Thirty-five advisory visits took the Silviculturist as far afield as Ladysmith, Bulwer, Umzimkulu, Isipofu, and Flagstaff and Lusikisiki in Pondoland. In the course of twenty-five visits, the Entomologist went three times to Umtali in Southern Rhodesia in connection with the chafer-beetle outbreak, while among other places visited were Kranskop, Piet Retief, and Umzinto.

During the period under review, there were upwards of 110 visitors to the Institute, of whom twenty-one came from places outside the Union. Among these latter were Mr. D. Akenhead, O.B.E., Director of the Commonwealth Bureau of Horticulture and Plantation Crops, who was accompanied by Dr. R. H. Marloth, of the Sub-Tropical Horticultural Research Station at Nelspruit, Dr. F. N. Howes, of the Royal Botanic Gardens, Kew, and Mr. L. Farrer-Brown, Secretary of the Nuffield Foundation. Also included were visitors from Northern and Southern Rhodesia, Kenya, Mauritius, Malaya, Sumatra, Denmark, Germany, and Holland. Among the visitors to the Field Experiment Station were Mr. Akenhead, Dr. C. R. Hursch, of the Southeastern Forest Experiment Station, North Carolina, and several groups of agriculture students. The General Committee of the Wattle Growers' Union also visited the Station in May, 1952.

Numerous organizations and individuals have consulted the Institute on the history, status, activities, and problems of the wattle industry. Among these may be noted the United Nations Food and Agriculture Organization, the Industrial Development Corporation, the Natal Town and Regional Planning Commission, the United States Consulate in Durban, and Mr. F. W. Ahrens, of the Historical Monuments Commission, as well as several commercial firms and a few students and research workers.

Memoranda were prepared for the Department of Forestry on the possibility of utilizing silver wattle bark and for the Wattle Growers' Union on the wattle bagworm situation in 1951-2.

The work of carrying out check analyses of Government Bark Inspector's samples, as foreshadowed in the Report for 1950, was started in January, 1951, and sixty-two samples have been analysed to date. In order to satisfy the requirements of the United

States Government, independent analyses have been carried out and certificates issued in respect of sixteen consignments of wattle extract. In addition, several bark and extract samples have been analysed in connection with advisory enquiries.

The Institute was mainly responsible for organizing and preparing the Wattle Industry Exhibit for the 1951 Royal Show in Pietermaritzburg, a task which made heavy inroads upon the time of the Institute staff during May and June. In 1952, the Exhibit was in the hands of the manufacturing side of the Industry and the Institute gave only minor help.

Senior members of the Institute staff prepared a series of seven semi-popular articles on wattle production for publication in *The Farmer* supplement to *The Natal Witness*, while the Director, at the invitation of the Department of Agriculture, wrote an article on the history of the wattle industry for the Special Van Riebeeck Number of *Farming in South Africa*.

Committees, etc.

In June, 1951, the Director attended the Annual Meeting in Grahamstown of the Research Advisory Council of the Leather Industries Research Institute and was accompanied by Dr. Martin, who represented the South African Wattle Growers' Union. The meeting in June, 1952, was attended by Dr. Martin representing the Director in the latter's absence overseas.

On the latter occasion, a meeting of the Leather Research Institute Wattle Technical Committee was held and another meeting took place in Pietermaritzburg in May, 1951. These meetings are making possible a closer and more positive liaison between the two Research Institutes.

The Director attended all the meetings of the General Committee of the Wattle Growers' Union except two held during his absence overseas, at one of which Dr. Moffett took his place. The Director and Mr. Sherry served on the Union's Research and Technical Committee, the Field Experiment Station Committee, and the Royal Show Exhibit Committee.

Mr. Sherry was a member of the Wattle Silvicultural Competition Sub-Committee and was responsible for conducting and judging the Competition. The fourteen plots entered were demarcated, measured, and judged during November and December, 1951. He also attended a meeting of the Ixopo Soil Conservation Committee to advise on the portion of the draft soil conservation scheme for that district which deals with wattle growing.

Dr. Ossowski was appointed to the Committee set up by the the Wattle Growers' Union to arrange and co-ordinate the large-scale aerial spraying operations against wattle bagworm in 1952. He had previously prepared for the Union's General Committee a memorandum on the subject, which was subsequently widely distributed to wattle growers.

The Chemistry Section has been largely occupied with collaborative work on the sampling and analysis of wattle bark and extract. This work, carried out in association with the Wattle Extract Manufacturers' Technical Committee, is described more fully on page 25.

Conferences, Lectures, Meetings, etc.

During his overseas leave, the Director visited some of the leading agricultural research stations and several other research laboratories in England. Many useful and informative discussions took place, in particular on the subjects of pest control, frost injury, and tannin chemistry. Some valuable new contacts were made and many old ones renewed. A visit was paid to the Fen District on the occasion of a Field Meeting

of the Association of Applied Biologists, when modern methods of weed control were demonstrated.

The opportunity was taken to inspect and discuss several major items of apparatus and equipment, purchase of which was contemplated by the Institute. This, together with independent advice and opinions from other research workers, greatly assisted final selection.

Mr. Sherry addressed farmers' meetings at Seven Oaks, Albert Falls, and Highflats on general wattle topics and at Ixopo on brushwood disposal and prevention of erosion. He also spoke at a Rotary Luncheon in Pietermaritzburg on the Role of Wattle in Soil Conservation. Dr. Ossowski gave two addresses on wattle protection to meetings of estates superintendents at Silverstream and Inyanga in Southern Rhodesia.

LIBRARY

During 1951, 18 books and 121 bulletins were received in the Library and for the eight months to 31st August, 1952, the increment was 10 books and 90 bulletins, making totals of 177 and 1,101 respectively. During the full period, 11 new periodicals and 4 reports were added, including *Plant Protection Overseas Review*, kindly presented by Messrs. Plant Protection, Ltd., England.

Classification and indexing of the bulletin material in the Library has continued as opportunity has arisen and good progress has been made. It is hoped that within the next year the task will be substantially completed and that the whole of this literature will then be readily accessible.

During 1952, a start was made on clearing the accumulated arrears of binding and the greater part has now been completed. These bound volumes not only safeguard the periodicals, but incidentally greatly enhance the appearance of the Library, whose shelves, populated mainly by piles of unbound journals, have hitherto presented a somewhat disarrayed appearance.

Since the publication in April, 1951, of the Annual Report for 1950, nineteen names have been added to the permanent mailing list, almost all at the request of the organizations and libraries concerned. Many valuable reports and other publications are received in exchange.

ACKNOWLEDGMENTS

The Institute is happy to acknowledge gratefully its indebtedness to the undermentioned individuals and groups for assistance rendered in a variety of ways during 1951-2.

To the Pietermaritzburg Corporation Wattles Department for the loan of their "Kyoritu" insecticidal fog machine and motor duster.

To the Pietermaritzburg City Engineer's Department for advice on surfacing and maintenance of part of the Institute surroundings.

To the Natal Provincial Water Engineer for advice and guidance on problems of water supply and storage at the Field Experiment Station.

To the Entomologists of the Commonwealth Institute of Entomology and the British Museum (Natural History) for assistance in identifying and naming entomological material.

To Dr. R. F. Lawrence, of the Natal Museum, for the identification of specimens of the order *Arachnida*.

To Professor A. A. Rayner, of the Faculty of Agriculture in the University of Natal, and to the Statistics Department of Rothamsted Experimental Station for advice on the layout of field trials and for assistance in the analysis of field data.

To Mr. J. C. Watson and the staff of the Chemistry Laboratory of the Natal Tanning Extract Company, Limited, for advice and information on many points connected with the analysis and utilization of wattle tannins.

To the growers who, in the interests of research, have accepted the inconvenience of experimental work carried out in their plantations and who, in certain instances, by their careful observations and reports have materially assisted the investigations.

The collaboration with the Permanent Technical Committee of the Wattle Extract Manufacturers' Association has been of the greatest value to the Institute in planning its research into analytical technique.

The Institute is indebted also to the Natal Tanning Extract Company, Limited, and its Estates Research Officer, Dr. J. Beard, for the privilege of receiving copies of internal reports on the Company's field investigations.

PART II. RESEARCH REPORT

PROGRAMME OF EXPERIMENTAL WORK IN PROGRESS AND PROJECTED

The following is a list of additions to the research programme. The full programme appeared in the Reports for 1948 and 1949.

ENTOMOLOGY

WORK IN PROGRESS :

1. Records of Insect Outbreaks.

Permanent records will be maintained for wattle insect pests observed and reported. Dates of outbreaks of the various pests, their intensity, areas infested, parasites, and other important details will be recorded to form the basis for early prediction of a recurrence of an outbreak. The co-operation of growers in reporting outbreaks, with all available details, is essential for the success of this work.

2. Wattle Insect Collection.

A collection of wattle insects will be started and arranged in a scientific series and in an economic one. Growers are invited to send to the Institute any new or unusual wattle insect. These specimens, after identification, will be included in the collection.

3. *Lyctus* Powder Post Beetles.

The efficacy of various kinds of insecticides against *Lyctus* powder post beetles in timber stacks will be tested. DDT and BHC will be used in the autumn during the larval and pupal stages and again in the summer during the copulation period of the borers. The insecticides will be applied by means of an insecticidal fog generator.

4. Particle Size of Oil Droplets.

It was observed during fogging operations that the density of the fog produced by the insecticidal fog generator varied greatly. Various oils of different viscosities will be used and measurements taken of the particle size of the fog obtained.

REVIEW OF WORK IN PROGRESS

(a) SILVICULTURE

1. Thinning Experiments Initiated by the Department of Forestry.

The thinning experiment in black wattle at Invernettie (Umzinto district) received its final measurement and was harvested in February, 1951. Owing partly to inadequate replication and partly to excessive loss of trees through accidental causes, no statistical analysis of the data from this experiment is possible. Yield differences between plots which received similar treatment were so great as to make even the most general conclusions of doubtful value.

2. Thinning Experiments Initiated by the Institute.

(*a*) Experiment No. S.1 at Broadmoor (Wartburg district) was thinned and measured in May, 1951, and January, 1952. An analysis of the data indicates that by three years of age on this site, only densities as low as 300 per acre are likely to be completely free-growing. The data showed, in addition, that plots with densities of 700 or more per acre at this age were suppressed to a significant degree in relation to plots with densities of 400 or less per acre.

(*b*) Experiment No. S.3 at Bloemendal (Pietermaritzburg district) was thinned in March and November, 1951, and was again thinned and received its first measurement in May, 1952. Growth of the trees has been good and, in the main, fairly regular over this experiment, but a few plots show irregular growth, which has had the effect of reducing their mean height in relation to the rest of the plots. This irregular growth seems to have been due to areas of particularly aggressive weed growth which suppressed the young wattle regrowth in the early stages.

(*c*) Experiment No. S.5 was laid down on the Clan Syndicate Estate (Albert Falls district) in October, 1951, and the trees were established in May, 1952, after the standing crop had been felled. It was originally intended to lay this experiment down at Yarrow (Howick district), as mentioned in the Report for 1950, but it proved impossible to fit the experiment into the ground available. This experiment, laid down on a first quality site, completes the set of three experiments originally planned to determine the optimum density of thinning for different rotation periods on first, second, and third quality sites respectively.

(*d*) The study of thinning and weeding in relation to the incidence of gummosis, Experiment S.2, Umvoti Wattle Company (Kranskop district), was thinned in January and July, 1951, and in March, 1952. The experiment was measured and scored for gummosis for the first time in July, 1951, and re-measured in March, 1952. The data from the first scoring indicate that at twenty-one months of age, there were significant differences due to thinning in mean breast height diameter of plots and that growth in plots which were weeded by hand-pulling was significantly better than in unweeded plots or in plots weeded by hoeing. There was also a significantly lower incidence of gummosis in the unweeded than in the weeded plots. An examination of linear and quadratic effects indicated, in the latter case, the existence of an optimum thinning intensity at which gummosis incidence will be at a minimum.

3. Row Espacement Experiment.

This experiment, No. S.4, was established in November, 1950, but mortality due to cold and drought during the winter of 1951 caused such variations in stocking between plots that it was decided to clear the area and re-sow it. This was accordingly done in September, 1951, and the experiment has received two thinnings since then and is now at a density of 1,000 trees per acre, with a mean height of about 6 feet.

4. Effect of Season of Green Pruning Upon Disease Incidence.

This experiment, No. S.6, was established in September, 1951 ; the trees have grown satisfactorily, but are not yet large enough to receive their first pruning.

5. Long-term Study of the Effects of Brushwood Burning on the Site and on the Crop.

A site for this study, Experiment No. S.7, was selected in Block 4, Bloemendal, during 1951. Treatments consist of

(i) stacking brushwood in piles 12 feet apart on the contour and burning all piles ;

(ii) stacking brushpiles 30 yards apart on the contour and burning alternate piles ;

(iii) stacking brushpiles 30 yards apart on the contour and leaving all piles unburnt.

The treatments are replicated five times, on land with different degrees of slope, in a randomized block arrangement.

On each plot, the run-off from an enclosed strip 0.01 acre in area will be caught and measured in a brick tank. Provision will be made also for trapping and measuring the amount of litter and soil carried down by surface run-off. The tanks are in course of construction and will be completed before the beginning of the rainy season.

6. Comparisons of Costs of Establishment of Wattle by Direct Sowing and by Planting Nursery-raised Seedlings.

This investigation, planned for 1951, was postponed pending investigations into the suitability of soil blocks and of various types of container for raising transplants in the nursery. It is hoped to carry out the experiment next season.

7. Effect on Increment of Defoliation by Bagworm.

Experiments laid down in collaboration with the Institute Entomologist at the Umvoti Wattle Company (Kranskop district), Mowbray and Spring Grove (Ahrens district), and Highlands (Richmond district), were thinned and measured during 1951. Analysis of the tree measurement data indicated that the members of plot pairs were comparable in vigour and rate of growth. Up to the time of measurement, the bagworm population had been too small to have any effect on increment.

8. Examination of Methods of Bark Sampling in the Field.

In collaboration with the Chemistry Section, bark samples were taken from individual trees at Bloemendal and samples of varying size were taken from a plot in an attempt to determine the size of sample required to give a valid estimate of the population. These studies are still in progress.

(b) GENETICS AND PLANT BREEDING

1. Breeding.

(*a*) *Green wattle* (Acacia decurrens). Selfing the first inbred generation of green wattle at Sweetwaters in 1949 and 1950 produced seed from 23 trees which was sown in October, 1951. These families were derived from 6 of the original parent trees selfed by Philp and Sherry (1946), *i.e.*, trees numbered G17, G20, G22, G26, G27, G28. Some of the recessive characters described by Philp and Sherry were identified and, in addition, a number of new recessives were recorded. Four of the new recessives were lethal factors which could be distinguished by morphological characteristics such as yellow-green, narrow, diminutive, or heavily-pigmented diminutive first seedling leaf. All died within four to six weeks of germination. Lethals occurred in 7 families derived from the original parent trees G20, G22, and G26. Three of the lethals behaved as simple recessives, but the fourth gave a ratio of normal to lethal which showed close agreement with expectation on a 15 : 1 basis. The light blue-green lethal described by Philp and Sherry could not be identified, although the seedlings were examined for this character by Mr. Sherry.

Amongst the other characters recorded were a non-lethal yellow-green leaf colour, a sub-lethal factor causing a white edge and subsequent death to the first seedling leaf, although later leaves developed normally, and a factor which caused elongation of the hypocotyl and also affected the internodes, producing plants taller than average. These all behaved as simple recessives.

In 4 families, all derived from the original parent tree G27, green as well as normal blue-green seedlings occurred. In 2 families, segregation for blue-green and green agreed closely with expectation on a 3 to 1 ratio, but in another family the ratio gave a good fit with a 15 : 1 expectation. In the fourth family, there were only 5 seedlings, all of which were green. These results suggest that the parent tree was heterozygous for duplicate factors. The parent tree G27 is recorded as segregating for normal blue-green and " lighter than normal " in a ratio which was in fairly good agreement with a 15 : 1 (Philp and Sherry, 1946). It is probable that Philp and Sherry's " lighter than normal " is the same as " green " of the present scoring, since scoring under varying conditions of light may alter colour classification. Further, in another sowing of natural seed of G27 made in 1951, 4 green seedlings similar to the inbred seedlings were recorded.

It is noteworthy that in the small amount of genetical work done so far in wattles, segregation of recessive characters has given, in 6 instances, ratios in close agreement with expectation assuming duplicate factors. Although these ratios have not been confirmed by further breeding tests, their frequency, taken in conjunction with cytological observations (unpublished), suggests that the present basic chromosome number in wattle ($x=13$) is a derived number and that the tan wattles are secondary polyploids.

Natural seed from the original parent trees was sown at the same time as the selfed families. Where sufficient seedlings were available in selfed families, they were planted in a trial with natural seedlings of the original parents to determine the relative drop in vigour due to a second generation of inbreeding.

(*b*) *Interspecific hybrids.*

(i) *Green* x *black wattle* (Acacia decurrens x A. mollissima). Sixteen families derived from F_1 hybrids between green and black wattles were sown. Six of these were F_2 families, 3 back-crosses to black wattle, 1 a back-cross to green wattle, and the remaining 6 from naturally produced seed of the F_1 hybrid trees. Seedling characters were studied, but a scoring for more mature characters has not been made as yet. The inheritance of seedling leaf colour is complex and the segregation has not been fitted into any genetical scheme which will explain all the facts. Certain aspects of the behaviour suggest that cytoplasmic inheritance is involved and further interspecific crosses have been made with this possibility in mind.

Of the F_1 hybrids used, one—G33/24—is recorded as having had normal blue-green seedling leaves without any trace of yellow, while of the other 5 trees, all in family G35, 4 are recorded as having shown a greater or lesser degree of yellow in the seedlings and the fifth as being light blue-green, but showing no yellowing (Philp and Sherry, 1949).

The F_2 from G33/24 segregated for blue-green and green seedlings in a ratio which might be 15 to 1 (P=0·10—0·05), but no yellow-green seedlings occurred.

The 5 F_2 families from the F_1 hybrids of family G35 all showed a wide range of segregation for seedling leaf colour. The colour of the first leaf ranged from normal blue-green through lighter blue-green, yellow-green, pale yellow-green, very pale yellow-green to (in 2 families) true albinos. The blue-greens and lighter blue-greens were, for the most part, easily distinguished from yellow-greens, but there was considerable difficulty in distinguishing between colours within each of these groups. In the 2 families in which albinos occurred, grouping the subsidiary classes gave a ratio of blue-greens to yellow-greens to albinos which could be interpreted as 9 : 6 : 1. In the other families, the ratio of blue-greens to yellow-greens varied between 1·5 : 1 and 1 : 1.

Back-crosses to the black wattle gave very different results from the back-cross to green wattle. In both cases, hybrid trees in G35 were used as seed parents and, as emasculation is not feasible, selfed seed as well as back-crossed seed may be produced. The 3 F_1 hybrid trees crossed with black wattle gave a higher set of seed than was obtained either by selfing or by open pollination (Report for 1950). Of the 300 seedlings grown from this cross, only 3 were yellow-green and these may, of course, have been due to self-pollination. The remaining seedlings were blue-green except for some which were greens or doubtful greens.

The back-cross to green wattle yielded only 22 seeds. Two seedlings were chimaeras of blue-green and yellow-green tissues (2 more chimaeras were noted at a later date) while the remaining 20 segregated into 10 blue-green or lighter blue-green and 10 yellow-greens, pale yellow-greens, or very pale yellow-greens. This back-cross was repeated in 1951, using 3 F_1 hybrid trees as seed-parents and the same pollen parent as previously. The set of seed from this cross was again low compared with that from the back-cross to black wattle.

The families from open pollinated seed showed the same range of blue-greens and yellow-greens as was observed in the F_2, but no albinos occurred. In the natural seedlings from the F_1 hybrid G33/24, there were 11 of the yellow-green type out of a total of 88, whereas none occurred in the F_2. From the position of the tree, it is concluded that these yellow-green seedlings were due to back-crossings to green wattle.

In the natural families in G35, 25-38 per cent. of the seedlings were of yellow-green types. Owing to the position and time of flowering of these trees, natural seed could have been due either to self-pollination, inter-crossing between the hybrids, or back-crossing to green wattle. A feature of these natural families was the high proportion of chimaeras which occurred, up to 13 per cent. being recorded. Some blue-green seedlings produced a single pale yellow-green leaf, while in others, a single pinna or even pinnule showed a colour difference. Chimaeras also occurred in the F_2 families, but in a much lower proportion.

A number of seedling characters other than leaf colour were noted in both F_2 and natural seed families. Three families segregated for a recessive character, pale cotyledons versus normal. All gave a close fit with expectation on a 3 to 1 ratio. Three families segregated for a striking character referred to as *compressed*. Internodes were reduced to practically nil, resulting in the leaves being bunched together on a very short stem, while the leaves themselves were smaller than normal and the spaces between both pinnae and pinnules greatly reduced. After six months growth, these " trees " had reached a height of less than 2 inches. In one family, the ratio of normal to compressed gave a fairly good fit on 3 : 1 expectation, but in the other two, the ratio fell between 3 to 1 and 15 to 1 and did not fit either.

Four families segregated for a recessive character, bipinnate first seedling leaf as opposed to the normal unipinnate type. The degree of expression of this character was very variable. Two families gave ratios in agreement with 3 to 1 expectation. The third family gave a ratio which was a fairly good fit to 15 to 1, but in the fourth there were too many recessives to fit this ratio (P=0·02—0·01).

(ii) *Further hybridization between green and black wattles.* A new series of hybrids was started, reciprocal crosses being made in some cases to test the possibility of the cytoplasm being concerned in the inheritance of seedling leaf colour. Using green wattle as seed parent, 3 out of 4 families from cross-pollinations with the same black wattle tree (B5) showed a high proportion of yellow-greens amongst the F_1 seedlings. The fourth family had only blue-green seedlings, which may, of course, be due to self-pollination. In spite of repeated pollinations, the yield of seed was low, ranging from 4 to 25 in the different families. Seed has been collected from only 1 reciprocal cross so far. The black wattle B5 x green wattle (E3) gave such a high yield of seed (300 from one inflorescence) that contamination is suspected. As the seeds were harvested late in the season, only 50 were sown, the rest being kept in reserve. Of the 45 which germinated, 36 were blue-green and 9 yellow-green. It is known that B5 does not segregate for yellow-green seedlings on selfing, so presumably the yellow-green seedlings, at least, are hybrid, but it is not possible to determine at this stage whether or not the blue-green seedlings are hybrids.

(iii) *Silver wattle* x *black wattle* (A. dealbata x A. mollissima). Reciprocal cross-pollinations were made between two silver wattle trees, S1 and S2, and the black wattle B5. Twelve seedlings were obtained from S1 x B5 and all showed a greater or lesser degree of yellowing. The reciprocal cross B5 x S1 gave a good yield of seed, but owing to the different ripening period of black wattle, the seed has not yet been sown. S2 x B5 yielded about 100 seeds, which have not yet been sown, while in the reciprocal cross the pods are still immature.

(iv) *Black wattle* x Acacia baileyana. Cross-pollinations of the black wattle B5 with *A. baileyana*, made in 1949, yielded 19 seeds, which were sown in 1951. Of the 15 seeds which germinated, 6 were classified as green and 9 as yellow-green. Further cross-pollinations between B5 and *A. baileyana* yielded 88 seeds, which have not been sown.

(v) *Silver wattle* x *green wattle* (A. dealbata x A. decurrens). Using the silver wattle tree S2 as seed parent, 112 seeds have been obtained from cross-pollination with green wattle. These seeds have not yet been sown.

(*c*) *Black wattle.*

Selfed and natural progeny. The selfed and natural progeny of 13 trees, mentioned in last year's Report, were transferred to the field at Bloemendal in February, 1951. Detailed scoring of field characters was commenced in June, 1952, but for various reasons had to be postponed and up to the present has not been completed. However, a preliminary survey to assess the characters to be scored showed striking differences between selfed and natural progeny from the same tree and in the progeny between trees. It was obvious, even without measurements, that the selfed seedlings were, on the whole, less vigorous than the natural seedlings. Marked differences were also noticed in branching habit, thickness of branches, number of lateral branches, density of foliage, forking, etc. A number of recessive leaf characters also appeared, chiefly various types of leaf curling.

2. Introductions.

Thirteen families raised from seed of *A. mollissima* and *A. decurrens* from different areas of Australia have been planted at Bloemendal for observation.

The Royal Botanical Gardens, Kew, have recently offered the collaboration of

one of their officers at present in Australia in collecting seeds of various *Acacia* species and strains. This opportunity was welcomed and the offer gratefully accepted by the Institute.

3. Colchicine Treatment.

A number of trees from seed treated with colchicine in 1948 and 1949 came into flower in 1951 and were examined for evidence of polyploidy. Some of these trees had large, coarse leaves, and flowers which were markedly larger than normal. Measurements were made of pollinia and stomata from colchicine treated trees of normal and abnormal appearance and from untreated trees. These measurements gave the following results (in microns) :

	Pollinia	*Stomata*
Untreated trees	44·88±2·06 x 40·92±2·43	26·48±2·21 x 15·88±1·86
Normal treated trees ..	44·00±3·61 x 40·56±2·58	28·28±2·35 x 16·32±2·24
Abnormal treated trees ..	55·80±3·88 x 49·56±2·64	34·16±2·69 x 18·72±2·30

Approximate chromosome counts were made in acetic orcein squashes of shoot tips from a small number of normal and abnormal trees. Where trees were normal in appearance, the diploid chromosome number ($2n=26$) was counted, but in abnormal trees, an accurate count of $2n=52$ was made in one instance, while it was evident, although accurate counts could not be made, that four others were also tetraploid.

Branches on a number of tetraploids and presumed tetraploids were bagged for selfing, while others were left to set natural seed. A considerable number of seeds which ripened prematurely have already been collected. The mean weight of these seeds was very much higher than the highest weight recorded in diploids. Two seeds were germinated and chromosome counts made ; both seedlings were tetraploid.

Tetraploids were formed after treatment with colchicine solutions ranging in concentration from 0·01 to 0·07 per cent., but at the higher concentrations, there was a low survival of seedlings. Treatment of seed (rendered permeable by removal of a small portion of the seed coat) with colchicine solutions of 0·02 or 0·03 per cent. for 24 hours would seem to give the best balance between survival and polyploids formed. The bulk of the tetraploid seed will be sown in the coming spring, when comparison between diploids and tetraploids will be made.

4. Progeny Testing of Parent Trees.

The progeny trial, consisting of families from natural seed of 25 selected trees and planted at Bloemendal in December, 1950, was scored for height in September, 1951, and again in July, 1952. At both scorings, there were highly significant differences in the mean heights of the families. Comparing the two sets of results, the relative positions of the families were much the same, with a few exceptions. At the second scoring, 1 family showed increased growth compared with the rest, while 3 others had dropped back considerably in position. Differences were noted in the habit and branching of the families, but these characters have not yet been scored in detail.

A second progeny trial comparing families from natural seed of another 21 selected trees was started in February, 1952.

5. Vegetative Propagation.

Attempts to propagate black wattle by cuttings treated with root hormones were unsuccessful. Many cuttings remained alive for several weeks and some put out short shoots, but all died eventually. Subsequent examination showed that a single cutting had developed one small root following treatment with indolebutyric acid.

A modification of the air-layer method of propagation used by Ledeboer (1944) was more successful. Instead of soil held in position round the branch by pieces of

split bamboo, a ball of moist sphagnum moss was placed over the ring-barked area and was held in position by a membrane. In the first instance, cellophane was used to cover the moss. Although 2 out of 5 layers treated this way rooted and were transferred to pots successfully, it was found that cellophane perished too quickly, allowing the moss to dry rapidly. Later tests were made with "Airwrap," a proprietary plastic membrane designed for this purpose. Using this membrane, 22 out of 43 air-layers on black, green, and hybrid wattles had developed roots after two months, while a further 7 formed callus and may form roots. Of the remaining 11, 2 branches broke and the rest had not formed callus at the time of writing.

Using this method, air-layers are not difficult to prepare and they require little attention. Even under dry conditions, watering once a month is ample. Water was injected under the tie at one end of the layer by means of a large hypodermic syringe. This promises to be a practicable method of propagation of wattles for genetical purposes.

6. Pollen Dispersion.

A preliminary experiment to test the wind dispersion of black wattle pollen was carried out. The most suitable area available for a test was an open piece of land with a dense bank of trees in full flower along the western boundary as the main source of pollen. There were, also, small groups of young trees flowering somewhat sparsely on the northern boundary and a larger row on the southern side. Pollen was collected on slides coated with glycerine jelly.

Three parallel lines of slides, each extending 1,500 feet, were placed at right angles to the western bank of trees and in as central a position as possible in the open land. Each line consisted of ten sites spaced at 150 foot intervals, and the corresponding positions in each were the same distance from the western line of trees. The parallel lines were 100 feet apart. At each site, four slides were exposed facing North, South, East, and West respectively. The outermost lines were 900 feet from the nearest flowering trees to the North or South. Two exposure periods were used, the first being for 48 hours and the second for 24 hours. During both periods, a strong north-west wind was blowing (Beaufort scale 6-7) and shade-temperatures were up to 102°F.

A very much larger number of pollinia (each pollinium consists of sixteen pollen grains) was collected on slides facing the wind, *i.e.*, North and West, than on slides facing South and East. In 48 hours, the average number of pollinia per three-quarter inch square of glycerine jelly was 756 facing North and West and 57 facing South and East.

Up to the limit of 1,500 feet, there was no marked difference in the number of pollinia collected at each position, but from 900 feet onwards, there was the possibility of contamination from the small trees on the northern boundary.

The experiment showed that there is a considerable amount of wind-carried pollen and that, under the prevailing conditions, there was little or no decrease in the concentration up to 900 or possibly 1,500 feet. It is hoped to repeat this experiment over a wider area free from lateral contamination and, at the same time, to correct some of the flaws in technique which became apparent.

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(c) CHEMISTRY

1. Fertilizer Experiments.

Height records from the Honey Grove experiment have been continued.

Lime was applied to plots of the main fertilizer experiment at Bloemendal in August, 1951, and the fertilizers were applied in the following November. The first height scoring was done after thinning in May, 1952.

Fertilizers were applied to the plots in the phosphate experiment at Bloemendal in November, 1951, and the first height scoring was done after thinning in May, 1952. Although this scoring was carried out only six months after fertilizer application, the plots receiving superphosphate showed up better than those receiving other phosphates, but the difference was not significant at that stage.

A third major fertilizer experiment and another phosphate experiment were laid out on the Clan Syndicate estates. Lime and phosphate treatments were applied in March and the other fertilizers in June, 1952. In the interval between the application of lime and that of the fertilizers, the experimental area was attacked by froghopper and as the damage appeared to be less on the limed plots, a count of damaged trees on all plots was carried out. Heights were scored also, as it was thought that the apparent preference of the froghopper for untreated plots might be a secondary effect. It was found, however, that although the froghopper damage was significantly higher in the untreated plots, there was no significant difference in the height records. It should be emphasized that the counts and height scoring were carried out before the major fertilizer treatments were applied and the observed effects could have been due, directly or indirectly, only to the effect of lime. There were no similar effects in either of the two other major experiments, in which the application of lime seemed rather to retard early tree growth. It is too early to come to any definite conclusion, and further experimental work on this point will be carried out.

2. Soil Analysis.

Soil samples have been drawn from individual plots of all the major fertilizer experiments. Mechanical analyses and determinations of pH and nutrients have been made to get some idea of soil variation within and between experiments. On the whole, variation is slight and the only feature of note is the small effect on pH of applications of lime. A 2·5-ton dressing of lime per acre on a fine, sandy loam at Honey Grove had raised the pH by 0·2 unit two years after application.

3. Bark Analysis.

Work done during the period under review includes the routine analysis of about 800 samples of bark by the International (Procter) method. These samples came mainly from silvicultural experiments initiated before the establishment of the Institute and harvested during the last three or four years. Sixty-two analyses have been carried out on samples submitted by the Government Inspector of Wattle Bark and the agreement between analytical results and his estimates has been reasonable.

All the above work has been carried out alongside a detailed investigation into the actual method of tannin analysis. Co-operative work with the Permanent Technical Committee of the South African Wattle Extract Manufacturers' Association, in which identical samples of bark or extract were analysed in five different laboratories, revealed a number of possible sources of error in the standard analytical technique. These may be classified under the following heads :

(*a*) Inefficiency in standard laboratory equipment.

(*b*) The analytical sample.

(*c*) The determination of moisture in ground bark.

(*d*) The drying and weighing of residues.

(*e*) The filter candles.

(*f*) The hide powder and non-tans.

(*a*) *Inefficiency in standard laboratory equipment.* As mentioned in the Report for 1950, it is essential to check and re-calibrate all standard equipment. A further fact emerged from the co-operative work in that difference in desiccator size affected residue weights. It was eventually established that the usual Scheibler-type desiccator design is most inefficient in that the air in contact with the drying agent in the base does not necessarily absorb moisture from the region of the cooling basin. This was obviated by ignoring the bottom compartment and fitting a tray containing silica gel (dried at 150°C. for 48 hours) on the desiccator ledge.

(*b*) *The analytical sample.* The official method calls for relatively coarse bark grinding, sieving to separate fibre and powder, and weighing off strictly proportional weights of fibre and powder for the sub-sample used in extraction. It has been found that, even when these operations are carried out with the utmost care, less concordant results are obtained than those obtained from sub-samples of completely pulverized material.

(*c*) *The moisture determination in ground bark.* Moisture percentages by the official method vary directly with atmospheric humidity in the laboratory at the time of determination. As all tannin percentages are calculated on a definite bark moisture content, this may lead to errors. This source of error was obviated by the use of an oven through which a current of hot, dry air was passed throughout the heating period and so designed that the lids of the containers could be put on before the oven door was opened.

(*d*) *The drying and weighing of residues.* Here again it was found that the final residue weights were dependent upon the atmospheric humidity. In this case, however, the final tannin percentage calculated, being the difference between total solubles and non-tans, is not subject to error provided that all operations are carried out at the same time and that the basins containing residues are kept in the same order during removal from the oven and in weighing This explains why, during the co-operative experiments, there was more variation in results from different laboratories in total solids, total solubles, and non-tans than there was in tannin percentage. A special oven of the type constructed for moisture determination would be necessary to obtain better values. It has been found advisable to restrict the heating period to two hours because there appears to be a tendency to loss of weight, possibly by decomposition during heating at 98°C., particularly in the case of some non-tan fractions.

(*e*) *The filter candles.* Different batches of filter candles show a great variation in speed of percolation, but this does not seem to affect the efficiency of filtration

(*f*) *The hide powder and non-tans.* The discrepancy in analytical results is greatest in the figure for non-tans. Whether this is due to variation in the hide powder or to inherent properties of the non-tans is not clear and investigation of these possible sources of variation is just beginning. The particular sensitivity of some non-tan fractions to decomposition at the normal drying temperature has already been noted. It is not unlikely that this, coupled with variation in bark moisture determination, accounts for the greater part of the day-to-day variation in tannin determinations.

(d) ENTOMOLOGY

1. Bionomy of Wattle Bagworm.

(*a*) *Biotic potential.* Data obtained in the seasons 1950-1 and 1951-2 are given below :

Season September-August	Average number of eggs per female	Sex ratio in June/July	Sex factor in June/July	Annual biotic potential*	Biotic balance†
		F : M			
1950-1	782	1 : 2·6	0·28	219	99·54%
1951-2	1,053	1 : 1·7	0·37	390	99·74%

* The annual biotic potential is calculated from the Thompson-Chapman formula, $p(zy)^n$, where p represents the original population, z the sex factor, y the number of progeny per female, and n the number of generations per year. In this case, p and n are each equal to unity.

† The biotic balance is derived from Bremer's formula, modified by Zwölfer,

$$\frac{100\left(e-\frac{M+F}{F}\right)}{e}$$

where e represents the number of fully developed eggs per female.

(*b*) *Distribution and density of bagworm population in trees and natural mortality at different heights of wattles.* The greatest *density* of population was found on the top of the trees in all height classes, whereas only in dominant trees up to 18 feet high and co-dominant and intermediate trees up to a total height of not more than 24 feet was the total number of bagworms highest on the upper 6 feet. The largest *number* of bagworms in all height classes except those mentioned above was in the section 6-12 feet below the top of the tree, while the section 12-18 feet below the top in different height classes carried 12·5-32·9 per cent. of the total bagworm population. The mortality of bagworms in the fifth instar and in the prepupal and pupal stage was fairly even through all sections of the tree, except in the lowest part of wattles inside the plantation, where mortality was up to 100 per cent., and was due mainly to the fungus *Isaria.* Polyhedral wilt also was the cause of some mortality and the bagworms killed by this disease were found mostly on the top of the tree. Polyhedral bodies exercise a pressure on the tracheal breathing tubes, resulting in a partial suffocation. It seems, therefore, that the bagworms infected with this disease may have migrated to the tree tops in search of more air. In the lower parts of the trees, practically no bagworms with polyhedral wilt were found.

The data in (*a*) and (*b*), except for the number of eggs, were obtained in the bagworm season 1950-1 from 38,278 dissected bagworms, collected from 169 trees in 12 different plantations, and in the bagworm season 1951-2 from 40,147 bagworms, collected from 167 trees in 17 different plantations. The number of eggs was obtained in 1950 from 10 and in 1951 from 22 females.

(*c*) *Population study.* The detailed population study was continued in seven plantations over an area of over 400 acres.

2. Development of Starving Bagworms.

Bagworms left without adequate food from their fifth or sixth instar passed through their normal number of instars, though growth was retarded, and pupated. Nearly all males emerged, but did not copulate. The females shrivelled up without producing a progeny.

3. Effect of Bagworm Attack on Increment.

The increment plots at Umvoti, Mowbray, Spring Grove, and Highlands estates were examined and thinned and measured in co-operation with the Silviculture Section at the end of the growing seasons 1950-1 and 1951-2. Thirty new plots were laid out, ten each in the Iswepe, Harding, and Ahrens districts.

4. Parasites and Predators of Bagworms and Other Wattle Insects.

The following parasites were found on bagworms:

Psocoptera :

Adults belonging to the genera *Caecilius, Ectopsocus,* and *Lachesilla,* species so far unidentified.

Nine different species of spiders were found preying on wattle bagworms, viz. :

of the family *Argyopidae : Araneus nigropunctatus* Lawrence and *A. strupifer* Simon ;

of the family *Clubionidae : Clubiona silvicolum* Lawrence, *C. pupilaris* Lawrence, and a *Chiracanthium* species ;

of the family *Thomisidae : Synaema imitator* Pav.;

of the family *Salticidae :* an *Evophrys* and a *Menemerus* species and another salticid of unknown genus.

Parasites and predators of other wattle insects were found and identified as follows :

on larvae of *Gonimbrasia tyrrhea* Cram.

Apanteles aethiopicus Wilkinson.

on pupae of *Gonometa postica* Wlk.

a *Brachymeria* species, undescribed.

on pupae of *Anadiasia punctifascia* Wlk.

Sturmia (*Prosturmia*) *idonea* B.B.

on larvae of *A. punctifascia*

a shield bug predator, *Glypsus maestus* Germ.

5. Control of Bagworm Migration.

Four rows of *Pinus patula* were planted at Bloemendal in spacing 9 feet by 9 feet around a block of wattles on the side of the prevailing wind.

The experiment laid out in 1949-50 on Newlands Estate had to be abandoned due to repeated damage, mainly by cattle.

6. Treatment of Advanced Bagworm Attacks.

The drastic measures recommended by the Institute for dealing with heavily-infested, nearly-mature stands have proved successful. They comprise felling and stripping the trees and burning the brushwood and are intended to be applied only in an emergency. When felling and burning was done between January and March, the remainder of scorched and starved bagworms showed a mortality of 95-98·5 per cent. In plantations where these operations were carried out between April and July, the mortality was 89-90·5 per cent.

7. Chemical Control of Bagworm.

(*a*) *Methods of application.*

(i) *Equipment.* A " Kyoritu " insecticidal fog generator acquired recently by the Institute was used for all experimental insecticide treatments and results so far obtained are promising. The apparatus has a total weight of 144 lb. (116 lb. without undercarriage) and is driven by a four-stroke single cylinder 2 h.p. petrol engine running at 3,000 r.p.m. The capacity of the petrol tank is approximately 1·1 gallons and the consumption approximately 0·2 gallon per hour. The insecticide tank holds 2 gallons and the insecticide is pumped into the exhaust pipe of the internal combustion engine, where it is converted into gas or fog by the hot gases from the engine. This fog is discharged by means of a high speed blower. The vertical carry, under favourable weather conditions, is up to 40 feet and the horizontal one up to 200 feet. The output is one gallon in 10 to 20 minutes and depends mainly on the heat of the engine and the rate of delivery of the insecticide into the exhaust pipe.

It seems that not only small centres of infestation, but also larger areas can be treated successfully. It is hoped to complete the final tests during the bagworm season 1952-3.

(ii) *Particle size of oil droplets.* Two experiments were carried out to compare the particle size of the fogs produced by the generator from four oils of different viscosities. The first experiment was an exploratory one for the purpose of finding out the best method of application. In it, slides covered with magnesium oxide were placed in frames 25 and 40 feet from the outlet. In the second experiment, four slides were exposed 30 feet from the outlet. No significant difference in particle size was revealed.

An account of these experiments is given on page 59.

(*b*) *Insecticidal fog treatment.* A series of experiments was carried out in the Hilton Road and Table Mountain districts to study some of the factors involved in the chemical control of bagworms, viz. :

(i) Different insecticides at various concentrations and rates of application.

(ii) Most suitable time of day for fogging operations.

(iii) Time of contact of insecticide with insect and plant to ensure a good kill.

(iv) Maximum effective distance of fogging.

(v) Stage of insect development.

The insecticides were applied by means of the " Kyoritu " fog generator. Though the experiments carried out are not yet complete, some practical conclusions can already be drawn from them.

(i) Three per cent. *gamma*-BHC or five per cent. Toxaphene, each in solution in the mineral oil Diesoline, will give a good kill of bagworms up to the third instar, provided a good cover is obtained. In plantations of 6 years and older, at least three gallons of insecticide per acre are necessary to obtain a fairly good cover. In younger plantations an amount of two gallons seems to be sufficient.

(ii) Fogging gives best results when carried out from 1 to 2 hours after sunset and onwards through the night until approximately 5.00 a.m. The average velocity of wind must not exceed five miles per hour (modified Beaufort scale 2). The greater the humidity of the air during operations, the higher the kill obtained.

(iii) To obtain a satisfactory kill, the insect as well as the food plant must be exposed to the insecticide for not less than 10 seconds. A shorter contact than this gave a low mortality.

(iv) A high mortality can be obtained up to 10 yards from the outlet of the fogging machine.

(v) The experiment started in 1950 to determine whether fogging during the copulation and pre-hatching period can stop or reduce hatching was continued and sample plots at Hilton Road and Table Mountain were treated in August and September, 1951, respectively. Ten per cent. Toxaphene in Diesoline was used in some plots and four per cent. *gamma*-BHC in others. The rate of application was one gallon per acre.

All bags taken for the assessment of mortality were dissected and 39·5 per cent. of males from the Hilton Road plantation and 99·9 per cent. from the Table Mountain area were found to have emerged. The mortality of females due to insecticide was 36·75 per cent. The females affected by the insecticide showed the same symptoms as in the previous season ; the insects were darker in colour and broke up very easily. The silk from inner bags was examined by the Chemistry Section to determine the labile chlorine content and the results are shown below :

Insecticide	Date of		Number of females collected	Dead or dying %	Mg. Cl per g. silk with females	
	treatment	collection			healthy	dead or dying
10% Toxaphene ..	28. viii .51	30. viii .51	32	46·9	trace	2·07
Control	—	30. viii .51	6	0·0	nil	—
10% Toxaphene ..	4. ix .51	5. ix .51	162	46·3	trace	0·93
10% Toxaphene ..	4. ix .51	5. ix .51	60	46·7	nil	2·38
10% Toxaphene ..	4. ix .51	5. ix .51	83	31·3	trace	1·45
Control	—	29. viii .51	74	0·0	nil	—
4% *gamma*-BHC ..	13. ix .51	14. ix .51	20	40·0	nil	5·66
4% *gamma*-BHC ..	13. ix .51	14. ix .51	117	12·8	nil	1·73
4% *gamma*-BHC ..	13. ix .51	14. ix .51	48	33·3	nil	3·66
Control	—	11. ix .51	206	1·9	nil	Not determined

As can be seen from the table, there had been practically no penetration of insecticide into the bags where the females remained healthy, but determinable quantities were found wherever there were dead or dying insects. All bags with affected females contained fertile eggs, and some bags contained hatching or nearly hatched bagworms, which died within the bag. Out of 330 bags with healthy females, however, only 16 contained fertile eggs. A reasonable inference from these observations is that penetration by the insecticide probably takes place via the copulation hole in the bag.

(*c*) *Insecticidal dust treatment.* Two experiments were carried out with a dust stated to contain 1·3 per cent. of the dimethyl ester of *p*-nitrophenylthiophosphoric acid. The insecticide was applied at the rate of 25 lb. per acre by means of a " Kyoritu " motor duster, kindly loaned by the Pietermaritzburg Corporation Wattles Department. Weather conditions during dusting operations were favourable ; a light wind (modified Beaufort scale 1-2) carried the dust evenly through the crowns of the trees. The bagworms were in their third and fourth instars and the assessment of mortality was done eight days after treatment. In the first experiment, eight trees were sampled per acre and the mortality was 29·1 per cent. (within a range from 6·6 to 53·7 per cent.). In the second experiment, twelve sample trees were taken and the mortality was 43·3 per cent. (within a range from 20·9 to 86·8 per cent.). This insecticide is said to penetrate

the leaf, thus minimizing the consequences of removal of the dust by rain. In fact, it was found that many trees in the treated plots were heavily coated with insecticide as much as eight days after treatment, even though heavy rains had fallen during that period. In spite of this good persistence, the resulting control was not satisfactory.

Although all possible precautions were taken during the operations, symptoms of slight poisoning, notably nausea and sleeplessness, were experienced by the operators for several days afterwards.

(*d*) *Use of repellents.* It was observed that the male bagworms did not alight for copulation on bags of females which were treated with insecticide. The insecticide apparently also acted as a repellent. It was further noticed that unfertilized females emerged very far from the bag and in many cases, losing their foothold, dropped to the ground

It appears that a strong repellent, coupled with a long residual effect, applied during or shortly after the emergence of the males, might reduce the annual biotic potential of bagworms.

8. Identification of Other Insects.

Insects extensively damaging green wattle plantations in the Albert Falls district were identified as citrus thrips, *Scirtothrips aurantii* Faure.

Insects attacking eucalypts in Zululand were identified as *Crossotarsus saundersi* Chap. and those destroying *Pinus patula* seedlings in Weza plantations were identified as belonging to the family *Curculionidae* and, according to the Commonwealth Institute of Entomology, form a new genus and species which will be described in due course.

9. Froghopper.

At Hill Crest, fifteen acres of 6 months old wattles infested with froghopper were sprayed commercially late in April, 1951. Five acres were sprayed with a two and a half per cent. solution and ten acres with a one per cent. solution of Toxaphene in Diesoline, applied with a hand-operated pressure sprayer at a rate of two gallons per acre. The assessment of the effect of spraying was done by the Institute. A kill of 98·9 per cent. was obtained.

Five acres of a progeny trial at Bloemendal were treated against froghopper late in May, 1951. Four per cent. *gamma*-BHC in Diesoline was applied at a rate of 0·2 gallon per acre, using the " Kyoritu " machine. At the time of fogging, nearly all capsids were adult and nearly all jassids in their nymphal stage. The mortality of capsids after fogging was 100 per cent. and that of jassids 1·8 per cent.

Two experimental blocks at Bloemendal, of an area of thirty-five acres, were swept for froghopper at fortnightly intervals from November, 1951, until January, 1952. The population during that time rose from 0·1 to 1·56 froghopper per sweep. The area was fogged in February with four per cent. *gamma*-BHC in Diesoline at a rate of 0·3 gallon per acre and subsequent sample sweeping showed that the froghopper population was reduced to 0·2 per sweep.

10. Chafer-beetles and Cutworms.

(*a*) The experiments on the effect of brush-burning against larvae of chafer-beetles were repeated in two plantations on dolerite soil. In each plantation, three observation pits were dug under the brushpile, and three thermo-couples placed one on the surface of the soil under the brushpile, one 0·5 inch below, and one 1 inch below the surface. Thermometers were placed 4, 6, and 10 inches in the soil below the brushpile. The temperature at the base of the brushpile rose in 10 minutes after setting the piles on fire to a maximum of 920°C. The temperature 0·5 inch below the surface of the brush-pile rose in 22 minutes from 19°C. to a maximum of 560°C. and fell in 38 minutes to

150°C. and in 98 minutes to 50°C. The temperature 1 inch below the surface rose in 19 minutes to a maximum of 360°C., while the temperature 4, 6, and 10 inches below the surface remained at 18°C.

It may be recalled that in 1950, similar experiments were carried out at Newlands (Report for 1950, page 29), and the results obtained there differed greatly from those of the experiments in 1951. It should be mentioned that the soil at Newlands is loose, porous, black loam, in marked contrast with the compact dolerite soil of the later experiment.

(*b*) The investigations into the life cycle of *Eulepida mashona* Arrow, which damages wattle plantations in Southern Rhodesia, were continued. It was found that the cycle appears normally to occupy one year. The adults start emerging after the first heavy rains in the spring, usually around October/November. Eggs are laid during November and December. The larvae hatch 14 to 18 days after the eggs have been deposited, moult four to five times, and attain their full size in the early winter. Pupation takes place usually at the beginning of July.

The damage done by larvae of *Anomala resplendens* Fahr. and *A.* sp.nr. *pinguis* Pering was found to be negligible and investigation of their life-cycle was discontinued.

A campaign against adults of *Eulepida mashona*, prepared by the Entomology Section, was started in November, 1951, and 3,080 acres of indigenous bush were treated with ten per cent. Toxaphene or four per cent. *gamma*-BHC, each in solution in Diesoline. The insecticides were applied by means of four " Kyoritu " fogging machines and one " Cooley " Mist Blower at a rate of 0·48 to 3·8 gallons per acre. The campaign, which extended over 960 working hours, resulted in a kill of 66,286 chafer-beetles per treated acre, enough to fill a 44-gallon drum.

An outline of the campaign against adult chafer-beetles to be carried out in November, 1952, has been prepared. It is intended to treat nearly 5,000 acres of indigenous bush.

(*c*) Two different brands of soil insecticide, each containing 0·45-0·50 per cent. *gamma*-BHC, were tried at four different rates of application on five acres of a progeny trial at Bloemendal to protect wattles against cutworm and larvae of *Anomala caffra* Burm. and *Hypopholis sommeri* Burm. It was found that 0·1 oz. of soil insecticide, inserted into each of four holes 10 inches deep and approximately 1 foot from the stem of the tree, gave a complete protection against these insects.

(*d*) The results of the two large-scale soil insecticide experiments laid out in Southern Rhodesia could not be analysed statistically since, through misinterpretation, the plots received different cultivations. It appears, however, that satisfactory protection follows the use of a soil insecticide containing at least 0·45 per cent. *gamma*-BHC and applied before the egg-laying season at a minimum rate of 22 lb. per acre in lines or around plants at final spacing.

The results of the Toxaphene soil insecticide experiment, laid out additionally on the Silverstream Estate, will be assessed in due course and, if possible, statistically analysed.

11. Miscellaneous Insects not Associated with Wattle.

(*a*) Lyctus *Powder Post Beetles*. An experiment was carried out at Broadmoor to test the efficacy of DDT and BHC against wood borer, *Lyctus brunneus* Steph. Four stacks of poles of *Eucalyptus saligna*, each stack of approximately 2,600 cubic feet, were covered with a tarpaulin. On the 1st May, 1952, two stacks were treated with five per cent. DDT and two with one per cent. *gamma*-BHC at the rate of one gallon per stack. The insecticide was applied by means of the " Kyoritu " machine and, in

order to obtain a greater coverage and to facilitate closer treatment of the piles, a metal extension was attached to the inner exhaust pipe. The results will be assessed after emergence of the beetles.

At the time of treatment, the borers were in their pupal and larval stages. The experiment will be repeated in September/October, 1952, during the flying and copulation period of the beetles.

(*b*) *Army Worm* (Laphygma exempta). At the request of the Pietermaritzburg Corporation, advice was given on combating the army worm which invaded some areas of the Corporation estates.

Two per cent. *gamma*-BHC or 3·3 per cent. Toxaphene, each insecticide in solution in Diesoline, was applied by means of hand-operated pressure sprayers at a rate of three to four gallons to the acre. The mortality of army worms 24 hours after treatment was 100 per cent.

By means of the " Kyoritu " machine, 3·3 per cent. Toxaphene in Diesoline was applied at a rate of 0·75 gallon per acre. The mortality of army worms 24 hours after treatment was 83 per cent., and 48 hours thereafter, 98·8 per cent.

12. Insectivorous Birds.

The investigations into the food of the hadedah ibis in relation to wattle plantations were completed. Thirty-one birds were collected from different parts of the wattle area in Natal, dissected, and the contents of the alimentary canal examined and listed. On this evidence, the main diet of the hadedah consists of insects, mainly coleopterous larvae, lepidopterous pupae, and other small invertebrates living in the soil. The species found in the alimentary canal were nearly always found also in sample pits dug in plantations where the birds were collected. Of the 1,906 specimens found in the digestive system, only 3·7 per cent. were indifferent or probably beneficial to wattle plantations, 24·6 per cent. were doubtfully harmful, and 71·7 per cent. definitely harmful. A full account of this investigation has been published (see page 75).

13. Insectary and Cage Breeding.

Specimens of wattle fauna have been kept under observation in the insectary. A portable field insectary was erected at Bloemendal for the study of the bionomy of some lesser known wattle insects.

Approximately 0·3 acre in the nursery was planted with wattles for insecticide tests and bionomy studies.

(e) MISCELLANEOUS

1. Collaboration with Other Organizations.

(*a*) *Studies on the tannins of wattle species.* Further samples of bark from various wattle species have been collected by the Silviculture Section for the Leather Industries Research Institute. These investigations have so far revealed a close similarity between the tannins of black, green, and silver wattle, but little information is yet forthcoming to explain the differences between these species.

(*b*) *Chemistry of wattle wood, etc.* Good progress has been made by the National Chemical Research Laboratory in its work on the composition of wattle wood, for which investigation further samples of wood have been sent by the Institute. Attention has so far been concentrated particularly upon the lignin fraction, while future plans include work on the hydrolytic production of sugars and their subsequent fermentation.

(*c*) *Spent wattle bark as a source of pulp.* With the co-operation of the Natal Tanning Extract Company's factory at Iswepe, a sample of spent bark was sent to Italy for examination. The results were negative.

2. Weed Control by Chemical Means.

In a statistically planned trial against American bramble (*Rubus sp.*), the sodium and monoethanolamine salts and the butyl esters of 2 : 4-dichlorophenoxyacetic acid and 2 : 4 : 5-trichlorophenoxyacetic acid were compared. The 2 : 4 : 5-T compounds were in each case far more effective than the corresponding 2 : 4-D compounds and in each series the sodium salts were inferior to the ethanolamine salt and the ester. The ethanolamine salt appeared to act much more slowly than the ester and it was not until four months after treatment that its effect became comparable with that of the ester. In the following spring, six months after treatment, 2 : 4 : 5-T ester showed up rather better than the ethanolamine salt, though there was little regrowth with either. The site of these experiments unfortunately became inaccessible shortly afterwards and further inspection and follow-up treatment of regrowth have not yet been possible.

In a subsequent trial, a selection of different esters of 2 : 4 : 5-T has been used, but only the earliest indications of the result are yet available.

Against bugweed (*Solanum auriculatum*), the esters were more effective than the amines and 2 : 4-D was slightly superior to 2 : 4 : 5-T, but no compound was completely effective. Six months after treatment, the results on an open, sunny site were much better than those obtained in deep shade.

PROGRESS REPORTS AND PAPERS

NATAL, HOME OF THE UNION WATTLE INDUSTRY*

By H. SHAW

In the late sixties of last century, the stocky figure of a one-time trader-mariner, John Vanderplank, was a familiar sight around his rough homestead a few miles outside Pietermaritzburg. His farm at Camperdown was a favoured outspan for travellers and farmers, many of them old acquaintances of his trading days, passing to and fro between the coast and the interior.

Vanderplank's claim to a place in history is that a few years earlier, in 1864, he had introduced into Natal seeds of the black wattle (*Acacia mollissima*), a tree which he had seen in the course of his visits to Australia. Impressed by the rapid growth of the wattle tree, he was quick to appreciate its potential value as a shade tree on the bleak and treeless farms of South Africa. The wattle flourished in its new habitat and within a few years, thanks to Vanderplank's generous distribution of seed to his visitors, it was found widespread over Natal and parts of the Transvaal. In this casual way, the foundation was laid of what has become one of South Africa's most important exporting industries.

Although he was doubtless aware of the established use of Australian wattle bark as a tanning material, Vanderplank seems to have had no other thought in bringing the tree to South Africa than to use it for shade, shelter, and fuel. Others, however, became interested in the possibility of commercial exploitation, and early in the seventies, tests were made in local tanneries to determine the quality of South African bark. These proved satisfactory and as a result, several individuals began to lay down commercial plantations. The first overseas shipment appears to have been a parcel of bark sent in 1886 to England, where Australian bark was then realizing £15 per ton. In the absence of any more appropriate freight category, the consignment was shipped at the high rate applicable to ostrich feathers! The net return, in consequence, was very small, but this modest venture marked the beginning of what is now a highly successful industry. In the peak year of 1949, 94,800 tons of wattle extract and 61,600 tons of dry bark were exported, the combined value just slightly exceeding £5,000,000. Because of adverse weather conditions and some previous over-cutting, 1950 showed a slight and probably quite temporary recession, but recent substantial increases in prices should result in a record value figure for 1951.

The United Kingdom is the chief market for these products, followed by the United States of America, Australia, Japan, and countries of Central Europe and the Middle East. Wattle extract has even penetrated the iron curtain into Eastern Europe and, indeed, apart from India, there are few countries where leather is manufactured on a substantial scale which do not import South African wattle in one form or another.

The three most important sources of vegetable tannins to-day are quebracho, chestnut, and wattle. Because quebracho is extracted from natural forests, principally in the Argentine, and is not being replaced by new plantations, it is progressively becoming more difficult of access and, therefore, more expensive. Chestnut is in an even more precarious position, for in both the United States and Southern Europe, it has been stricken by a disease which threatens to exterminate existing plantations.

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Already in America the chestnut tannin industry is surviving only by the utilization of dead trees left standing in the once flourishing forests. In these circumstances, wattle emerges as the one major source of vegetable tannin which is grown on a large-scale sustained yield basis capable of fairly rapid expansion. This is possible because it is grown as a plantation crop, coming rapidly to maturity in ten years or less.

There are now at least 550,000 acres of wattle plantations in the Union of South Africa and new land is steadily being brought under this crop. There is widespread activity in establishing plantations in other countries also, notably Kenya, where a substantial industry is already in existence, Southern Rhodesia, Tanganyika, Brazil, and India, whilst in Australia there is a considerable production from indigenous bush.

The best areas for wattle production in South Africa are those situated between about 2,000 and 4,500 feet in the so-called " mist-belt " and having an annual rainfall of not less than 35 inches. These are found chiefly in the midlands of Natal, in Southern Zululand, and in the South-eastern Transvaal.

The initial planting of new ground is done from collected seed. Under favourable conditions and good silvicultural practice, re-establishment after each harvest can usually be effected naturally from the accumulated seed in the ground. In more difficult circumstances, however, it may be necessary to re-seed for each cycle. The crop requires considerable attention during its first two or three years, mainly to bring it into lines at the correct espacement and to control weed growth. The tree rows are from six to twelve feet apart and the first task is to clear out all unwanted regrowth between the lines. The trees are then progressively thinned until they stand at a final density of 400 to 600 trees per acre, according to site quality, individual preference, and local practice. From this point until preparations for harvesting commence, little attention is required apart from measures to control pests where necessary. The chief of these latter are the wattle bagworm and a group of capsid and jassid bugs known collectively as " froghopper." Promising results have been obtained in combating these insects, but complete control has not yet been achieved, mainly because of the lack of really suitable and effective means of applying the insecticides.

The bark of the black wattle reaches maturity in about eight years, but the weight of bark continues to increase for some years after that. The length of the cycle on which wattle is grown ranges, therefore, from eight to twelve or even more years, according to circumstances, the general average and most common practice being rather less than ten years. When the trees are considered to have attained their maximum economic yield, they are felled and stripped of bark. This is done in the rainy season, usually about October to April, for in all but a few high-rainfall areas, this is the only period during which the bark will strip cleanly from the wood.

Where the bark is to be used for the production of extract and there is a factory within a convenient distance, the bark is transported green within a few hours of stripping. Where there is no factory in the vicinity or where bark is intended for the millers, it is dried in the plantations and marketed as dry or stick bark. The quality of the product is markedly affected by the care taken during this drying. Ideally it should be carried out quickly, but out of direct sunlight and in a free moving current of air. The bark should also be protected from rain, which induces mould growth with consequent deterioration in quality. The yield of dry bark varies with locality, site quality, and silvicultural practice. The general average at present approaches four tons per acre, but yields of six or seven tons are sometimes realized, and even higher yields are attainable.

The tannin content of dry bark lies usually between 30 and 40 per cent. and is most commonly within the range 34-38 per cent. When intended for export as bark, this material is bought by the millers, blended, chopped or ground according to the product required, and baled. All bark exports are subject to government inspection and every consignment is sampled and graded on physical examination by the bark inspector. The three grades in use are prime, average, and merchantable, corresponding more or less to tannin contents of over 37 per cent., 35-37 per cent., and below 35 per cent. respectively. Grading, however, takes into account also colour and general condition. Every package of bark exported carries the official mark and grading.

The manufacture of wattle extract involves a more complicated process consisting in essence of extraction of the bark by hot water and concentration of the resulting solution. Whether green or dry, the bark is chopped into small pieces and filled into the extraction vessels. These are arranged on the counter-current principle, *i.e.*, the nearly spent bark meets fresh water coming into the cycle, whereas the fresh bark is first extracted by a solution already charged with tannin. The first stage of concentration of the extract takes place in multiple-effect evaporators and the process is completed in vacuum pans. Here, the liquid is taken to such a consistency that it solidifies on cooling. The concentrated liquor is run straight from the pans into jute or hessian bags which hang on racks until the extract solidifies. Because of its deleterious effect on the colour, no iron may be used in the plant, which consists almost entirely of copper vessels, though wooden vats are used in some of the older extraction processes.

Wattle extract is manufactured and sold to a guaranteed minimum tannin content of 60 per cent. Largely under the stimulus of pressure upon shipping space in two world wars, it has advanced rapidly in favour as compared with dry bark until to-day approximately three-quarters of the total quantity of wattle bark grown in South Africa is exported in the form of extract. Durban, being the nearest port to the main wattle-growing areas, is the chief centre for the export of wattle products, though small parcels of bark occasionally pass through other South African ports.

The chief use of wattle is, of course, as a tanning agent in the leather industry, and the current demand for that purpose alone far exceeds the supply. There are, however, other interesting uses to which wattle extract in particular could be put if adequate supplies were available. It has been used successfully for tanning fishing nets, ships' rope, sails, etc. ; under suitable conditions it can be made to condense to produce very serviceable moulded plastics ; and it is an effective water-treating agent. Probably the greatest potential outlet, however, other than tanning, is as an alternative to quebracho in preparing viscosity-reducing agents for use in oil-well drilling. These agents control the viscosity of the mud produced in the well and so facilitate drilling operations.

An important by-product of the wattle industry is the timber which remains after the bark has been removed. Accurate figures are lacking, but this may amount to as much as one and a half million tons per annum of which, at present, a large proportion is not utilized commercially.* The chief existing outlets are for mine timber and firewood, while smaller quantities are used in the manufacture of hardboard, paper, treated poles, and charcoal. The surplus wood, now burnt or left to rot in the plantations, constitutes a potentially valuable raw material which, in the prevailing circumstances of a world shortage of exploitable cellulose materials, offers several interesting possibilities.

Because of its inherent characteristics, wattle wood is unlikely to find direct application as a structural timber except, perhaps, in the form of short and narrow pieces of strip floorboards. It has already been established, however, that other applications are technically possible. Of these, the manufacture of parquet floorblocks of a quality to compete with the best hardwoods is on the way to becoming an established industry. Among other possibilities are pulp manufacture, destructive distillation, and hydrolysis and fermentation. Although each of these could produce substances in world-wide demand to-day, the first is especially attractive because it seems to be the one outlet capable of making substantial inroads into the surplus timber available. Because of its short fibre, wattle wood is more suited to the production of rayon-pulp than of paper-pulp, and if the problem of water supply can be solved, it is not improbable that another valuable and much sought commodity may be added to those already arising from the wattle industry.

In the foregoing account, an industry is described which at the moment is enjoying a large measure of prosperity. It is not, however, thereby blinded to the demands of the future and is especially conscious of the need for progressive development by means of research. From a contribution paid by growers on every ton of wattle bark

* This was written in April, 1951. In the intervening eighteen months the situation has changed materially, and to-day all accessible wattle timber can be disposed of readily.

handled by the millers and the extract manufacturers, the South African Wattle Growers' Union has built up a fund from which for some years past generous grants have been made to support research. These have included *ad hoc* grants for specific projects, a long-term guaranteed annual grant to the Leather Industries Research Institute at Grahamstown, and, above all, the major part of the funds necessary to establish and maintain the Wattle Research Institute in Pietermaritzburg. This came into being in 1947 as an integral part of the University of Natal, its erection and equipment being financed jointly by the Wattle Growers' Union and the Government Department of Education. Its subsequent maintenance is the joint responsibility of the Union and the Department of Forestry. Here, a team of experienced scientists is engaged upon investigations which are designed not only to provide answers to the current practical problems of the industry, but also to sustain the flow of new knowledge and ideas which alone can replenish and revitalize the fountain of information and advice available to growers.

DIFFERENTIAL GERMINATION IN THE BLACK WATTLE (*ACACIA MOLLISSIMA* WILLD.) CAUSED BY SEED TREATMENT

By A. A. MOFFETT

The black wattle (*Acacia mollissima*) produces hard-coated seeds requiring some form of treatment prior to sowing in order to render them permeable. Chipping the seed coat with a razor or immersing the seed in hot or boiling water have the desired effect, the former method giving the higher germination.

All seeds are not equally hard-coated. An interaction between hot water treatment and seed coat sensitivity to it leads to differential germination, the degree of which depends upon the severity of the treatment. When seed is divided into three size groups, the larger seeds have a higher proportion with sensitive coats than have medium or small seeds. This results in a depression in the percentage germination of the larger seeds following the severer treatments and an increase in germination following the milder treatments compared with smaller seeds.

Hot water treatment may affect the embryo adversely, slowing down or depressing germination and, at the same time, rendering the seed more liable to fungal or bacterial attack. The weight of this attack may accentuate or modify the differential germination.

The adverse effect of hot water treatment is not necessarily permanent; under favourable conditions, such as dry storage, seed may recover to a considerable extent from treatment effect.

There is some evidence that seed size in wattle is at least partly controlled by genetic factors. It is suggested that by using hot water treatment, seed is subjected to a hitherto unsuspected selective force.

Introduction.

The wattle belongs to a group of plants producing hard-coated impervious seeds, capable of remaining dormant for many years even under moist conditions. To produce rapid germination, some form of seed treatment is necessary, the usual procedure being to pour the seed into boiling water and allow to cool and soak for several hours. Other methods of inducing germination were tried in connection with colchicine treatment of seeds, since hot water treatment is unsuitable for this particular purpose. It was found that a small cut through the seed coat produced a higher and more even germination than boiling water treatment and, at the same time, it was noticed that there appeared to be a higher percentage of twin seedlings amongst the cut seeds. The apparent deficiency in the number of twin seedlings, coupled with the overall reduction of germination, suggested the possibility that boiling water treatment was having a differential effect on the seed sample. Since such an effect, if it occurs, is likely to be of importance from the genetical point of view, it was decided to pursue the matter further.

Previous Work on Wattle Seed Treatment.

Maiden (1906) described various methods of treatment such as frying in a pan or treating the seed with hot coals or boiling water, while Sim (1927) recommended pouring boiling water over the seed and leaving it to soak "until soft enough to be cut in two without trouble by thumb nail pressing against the first finger." A second application of boiling water was recommended, if necessary. The first attempt at controlled tests was made by J. B. Osborn and E. Osborn (1931) and their findings have been largely substantiated by the results of the present investigations. Briefly, their conclusions were as follows:

(i) Treatment such as recommended by Sim was unnecessarily severe. Seeds whose physical appearance remained unchanged by normal treatment with boiling water germinated freely.

(ii) The best method of pre-treatment found was to place the seed in many times its volume of boiling water, and to allow it to cool immediately and remain soaking overnight or for ten or twelve hours.

(iii) Boiling seed for twenty minutes killed a certain proportion, depending upon the sample concerned. In the case of seed collected from the floor of the plantation, this amounted to a small percentage only, but in hand-picked seed, the mortality was higher, being over 50 per cent. in individual trees.

(iv) Storage after treatment with boiling water in no way impaired germinating ability; on the contrary, it improved it.

Material and Method.

As it was the apparent deficiency of twins following boiling water treatment which drew attention to a possible differential effect, size was used as a criterion for dividing seed into groups, since it seemed probable that seeds containing twin embryos would, in general, be larger than the average. The seed was sorted visually into three groups referred to as large, medium, and small. The proportion of seed falling into each of these groups varied not only with the sample of seed, but also with the operator doing the sorting. On the average, the proportions were 35 per cent. large, 43 per cent. medium, and 22 per cent. small; the thousand-seed weights were 17·0 g., 14·7 g., and 12·0 g., respectively.

Five different samples of seed were used for the trials. Two of these were collected from trees at the Genetics Station, Sweetwaters, one in December, 1947, and the other in December, 1948. Three samples of commercial seed were also used. Commercial seed is collected by scraping up the litter from the floor of a plantation, sifting, and winnowing. Seed obtained in this way is of mixed ages, some possibly being very old if the site has been under several cycles of wattle; there is evidence that wattle seeds can remain viable in the soil for at least fifty years.

Preliminary germination trials were carried out at room temperature, but fluctuations due to rapid weather changes were so great that subsequent trials were made in an incubator at a temperature of 84°F. This temperature was possibly above the optimum, but, as room temperatures frequently reach this figure during the warmer months, lower temperatures could not be used if consistency were to be maintained all the year round.

When seed was prepared for germination by cutting, a small chip of the seed coat was removed from the distal end. Seeds so treated are referred to as " chipped." The main range of treatments consisted of hot water at various temperatures, or boiling for various periods of time. When treatment was at boiling point or temperatures below boiling, the water was brought to the correct temperature, the seed poured in, and the vessel removed from the hot plate immediately. The seed was allowed to remain in the water to cool and to soak for approximately twelve hours. For prolonged boiling treatments, water was brought to the boil, the seed poured in, and the water maintained at boiling point for the required period of time. The vessel was then removed from the hot plate and the seed allowed to cool and soak as before. In all cases, a constant proportion of 0·5 ml. water per seed was used.

Laboratory germination tests were made on moist cotton wool in petri dishes. Tests in soil were made in a nursery bed without any special precautions.

Twenty-five germination trials were made to verify results and to check doubtful points; results of a few only are given to demonstrate the general germination behaviour. All treatments were replicated and the results examined by an analysis of variance, percentages first being converted to angles of equal information. The standard errors and significant differences given below the tables refer to these converted figures only. A dash here indicates that differences were not significant.

Results of Preliminary Trials.

The first germination trial with seed divided into size groups was made in warm weather during September, 1948. A sample of commercial seed of unknown origin was divided into four groups—large, medium, small, and unsorted—and was prepared

for germination in two ways. One series was treated with water at boiling point (but not boiled) and the other by chipping the seed coat. Tables I and II give respectively the germination six days after treatment and the final germination four days later.

TABLE I.

Trial No. 1. Germination after six days—commercial seed.

Treatment	Seed size									
	Germination %					Angle				
	Large	Medium	Small	Unsorted	Mean	Large	Medium	Small	Unsorted	Mean
Boiling water	71	81	92	75	79·7	57·6	64·7	73·8	60·1	64·1
Chipped ..	94	98	94	95	95·2	76·0	85·9	76·3	78·9	79·3
Mean	82·5	89·5	93·0	85·0	87·5	66·8	75·0	75·1	69·5	71·7

	Treatment	*Seed size*	*Interaction*
Standard error	1·470	2·078	2·939
Significant difference (P=0·05)	4·29	6·07	8·58
Significant difference (P=0·01)	5·81	—	—

TABLE II.

Trial No. 1. Final germination—commercial seed.

Treatment	Seed size									
	Germination %					Angle				
	Large	Medium	Small	Unsorted	Mean	Large	Medium	Small	Unsorted	Mean
Boiling water	86	90	94	82	88·0	68·3	74·4	77·7	65·4	71·4
Chipped ..	94	99	96	96	96·2	78·9	87·2	80·1	81·8	82·0
Mean	90·0	94·5	95·0	89·0	92·1	73·6	80·8	78·9	73·6	76·7

	Treatment	*Seed size*	*Interaction*
Standard error	1·926	2·725	3·851
Significant difference (P=0·05)	5·62	—	—
Significant difference (P=0·01)	7·62	—	—

Chipped seed germinated more rapidly and gave a higher final germination than hot-water treated seed. Seeds which failed to germinate following chipping were examined and in all cases it was found that the embryo was shrivelled and obviously had died some time prior to the commencement of the trial. All " full " seeds germinated. The percentage germination following chipping may be taken as a close approximation to the potential germination of a seed sample and, as such, forms a useful figure for comparison when assessing the effect of other treatments.

The germination behaviour changed as germination proceeded, as is shown by the comparison of results six days after treatment and at the completion of the trial. Six days after treatment (Table I), the germination showed a significant interaction between seed size and treatment which was especially marked following hot water. In the chipped series, the interaction differences just reached the level of significance, but

further experiments did not confirm this result, which may have been purely a chance effect. The significant interaction showed that there was a probability that treatment, especially hot water treatment, did not affect seeds of different sizes to the same degree.

The final germination presented a somewhat different picture. The percentage germination in the size groups had largely evened up, with the result that the interaction was no longer significant. The experiment suggested that while hot water and possibly chipping treatment do not affect all seeds to the same degree, the effect is a transient one from which the seed could recover.

In November, 1948, a further trial (No. 2) was commenced using seed collected from Sweetwaters in December, 1947. The seed was divided into three size groups as before, with two series, one of which was treated with water at boiling point and the other soaked in concentrated sulphuric acid for 20 minutes. The potential germination of the seed sample was determined from chipped seeds prior to sorting and was found to be 95 per cent. The results of this trial are summarized in Table III.

TABLE III.

Trial No. 2. Final germination—Sweetwaters, 1947, seed.

Treatment	Seed size							
	Germination %				Angle			
	Large	Medium	Small	Mean	Large	Medium	Small	Mean
Boiling water ..	56	81	87	74·7	48·5	64·6	69·8	61·0
H_2SO_4	33	26	16	25·0	34·8	30·6	23·4	29·6
Mean	44·5	53·5	51·5	49·8	41·7	47·6	46·6	5·3

	Treatment	*Seed size*	*Interaction*
Standard error	1·855	2·269	3·211
Significant difference (P=0·05)	5·51	—	9·54
Significant difference (P=0·01)	7·55	—	13·07

Both treatments gave a very much lower germination than the potential established by chipping, but hot water treatment was very much superior to the sulphuric acid treatment. The most interesting result of the trial was the highly significant interaction between seed size and treatment. In both series, though the interaction differences were significant, there was a complete reversal of effect. The hot water treatment showed, to a more marked degree, the same trend as had occurred in the first trial, but following soaking in sulphuric acid, large seed gave the highest germination followed by medium and small. Examination of seeds which failed to germinate showed one marked difference between the treatments. Seeds which had failed to germinate after the hot water treatment absorbed water readily but were quickly attacked by fungi and bacteria, and decayed. These seeds had evidently been either killed or severely damaged by the treatment. Following sulphuric acid treatment, many seeds failed to absorb water. When these were chipped subsequently, they germinated readily, indicating that the treatment had not been severe enough to produce a high germination.

The most likely explanation of the interactions would seem to be that the seed coats of the size groups differ in sensitiveness to treatment, that of the large seeds being more susceptible than that of medium and that of medium being more susceptible than that of the small. Treatment with boiling water being sufficiently severe to reduce the potential germination, the more sensitive seeds were more drastically affected, with a resultant depression in germination. The sulphuric acid treatment, on the other hand, was not sufficiently severe to produce high average germination, the seed on the

whole being "under treated." Under these conditions, the larger seeds, being more sensitive, were at an advantage and produced a higher relative germination than the smaller.

One other point of interest in the preliminary trials is worth noting. In Trial No. 1, the depressing effect of hot water treatment on the germination of large seed was evident in the early stages of the test, but by the time germination was completed, this difference was not so marked. In Trial No. 2, on the other hand, the effect persisted to the end. Evidently the detrimental effect of boiling water on portions of the seed is not necessarily fatal, for under certain circumstances, seeds can recover, while under other conditions the effect may persist.

Trials to Test Differential Seed Coat Sensitiveness.

If the explanation of the interaction noted between seed sizes and treatment in the preliminary experiments is correct, then with less severe treatments using hot water at temperatures below boiling, a point should be reached at which germination of large seeds should equal, and at still lower temperatures exceed, that of medium or small seeds.

To test whether this is so, a further trial (No. 3) was made with seed collected from Sweetwaters in 1948. The seed was divided into three groups as before, each group being treated with hot water at 60°C., 70°C., 80°C., 90°C., boiling point, and by boiling for 5 minutes. Germination took place in an incubator at 84°F. The results of this trial are given in Table IV.

TABLE IV.

Trial No. 3. Final germination—Sweetwaters, 1948, seed.

Treatment	Seed size							
	Germination %				Angle			
	Large	Medium	Small	Mean	Large	Medium	Small	Mean
60°C.	57·5	45·5	30·0	44·3	49·36	42·28	33·20	41·61
70°C.	88·5	61·5	49·0	66·3	70·26	51·70	44·42	55·46
80°C.	92·0	91·5	87·0	90·2	74·42	73·47	69·15	72·55
90°C.	89·5	91·5	93·0	91·3	71·36	73·07	74·96	73·13
Boiling point	83·5	92·0	92·5	89·3	66·27	74·89	74·82	71·91
5 minutes boiling ..	55·5	62·0	71·5	63·0	48·18	52·07	57·73	52·64
Mean	77·7	74·0	70·5	74·1	63·31	61·25	59·05	61·20

	Treatment	*Seed size*	*Interaction*
Standard error	1·386	0·980	2·402
Significant difference (P=0·05)	3·93	2·78	6·82
Significant difference (P=0·01)	5·25	3·71	9·10

The results show a highly significant interaction between seed size and hot water treatment in close agreement with expectation on the hypothesis outlined above. Germination was highest in the intermediate treatments and fell away when the treatment was either milder or severer. In the former case, it was shown by the number of seeds which failed to absorb water, but which germinated subsequently on chipping, that the lower germination was due to the treatment being too mild. Following severer treatments, all seeds absorbed water, but those which failed to germinate decayed, presumably due to the embryo being killed by the treatment.

The difference in germination between size groups and the interactions between

seed size and hot water treatment were not so clear cut in all trials. Another trial (No. 4), made at room temperature during cool weather, showed no interaction between seed size and treatment, although seed from the same samples as Trial No. 3 was used and tested over the same range of treatments. There was some difference in the percentage germination between the size groups following treatment at 80°C., but the difference did not reach the level of significance. The only pronounced variable between the trials appeared to be the temperature at which germination took place.

Commercial seed was also tested (Trial No. 5) over the same range of treatments as in Trial No. 3. Again there was a significant interaction, but the differences were not so great as in No. 3. In the early stages of germination, differences between the size groups were marked and the interaction highly significant, but as germination approached completion, there was a tendency for these differences to become less. Commercial seed was, on the whole, not so easily damaged by treatment as seed collected from the trees, and it showed a greater degree of recovery.

While the significant interactions showed clearly the differential sensitivity of wattle seed of different sizes to hot water treatment, at the same time, the negative results of Trial No. 4 indicated that other factors were at work which could modify, or even obliterate, the differential effect of treatment, and that the same result could not be expected under all circumstances. It was noticed in all experiments that the severer the treatment the more susceptible did the seed become to fungal and bacterial attack. The weight of this attack was a factor of considerable importance in determining the final germination percentage.

Germination Trials in Soil.

The germination tests described above were made in the laboratory in petri dishes. The fact that external conditions could modify the results of a test made it important to know whether similar differences occur when treated seeds are sown in soil. Two trials were made, the first (No. 6) using Sweetwaters 1948 seed and the second (No. 7) using seed from the same commercial sample as Trials Nos. 1 and 5. The same range of treatments as in Trial No. 3 was used in both cases. The results of Trial No. 6 are given in Table V.

TABLE V.

Trial No. 6. Final germination—Sweetwaters, 1948, seed.

Treatment	Seed size							
	Germination %				Angle			
	Large	Medium	Small	Mean	Large	Medium	Small	Mean
60°C.	44·2	29·2	20·8	31·4	41·63	32·62	26·93	33·73
70°C.	65·8	58·3	35·8	53·3	54·33	49·88	36·58	46·93
80°C.	79·2	66·7	73·3	73·1	63·18	54·91	59·13	59·07
90°C.	83·3	85·8	78·3	82·5	65·93	68·01	62·68	65·54
Boiling point	76·7	83·3	83·3	81·1	62·57	66·46	66·15	65·06
5 minutes boiling ..	27·5	46·7	57·5	43·9	31·60	43·01	49·48	41·36
Mean	62·8	61·7	58·2	60·9	53·21	52·48	50·16	51·94

	Treatment	*Seed size*	*Interaction*
Standard error	2·075	1·252	3·542
Significant difference (P=0·05)	6·25	—	10·17
Significant difference (P=0·01)	8·64	—	13·64

Although the mean germination of all groups was lower in soil, as was to be expected under the more hazardous conditions, correspondence of germination behaviour with comparable seed treatments in the laboratory was striking. At boiling point, the lower germination of large seed compared with medium or small did not reach the level of significance, but there was a definite trend which, coupled with the results of other experiments and the fact that external conditions can modify the results, suggests that under some circumstances, real differences between size groups would occur following normal treatment.

In the second trial in soil, comparing the same range of treatments on commercial seed, the germination behaviour again showed considerable agreement with that occurring in the laboratory when seed from the same sample was used for the trial. Recovery from treatment was greater than in the hand-picked Sweetwaters seed. Twelve days after sowing, there was a significant difference in the germination between groups treated at 60°C. and by 5 minutes boiling, but by the time the germination was completed, although the difference between groups treated at 60°C. still remained, there was no difference following 5 minutes boiling.

The Recovery of Seed From Treatment Effect.

The experiments showed that hot water treatment apparently acted on the seed in two ways. First, there was a differential sensitiveness of the seed coat so that all embryos were not affected to the same degree by a treatment and secondly, arising out of the differences in sensitiveness of the seed coat, there was an effect on the embryo which delayed or destroyed its ability to grow. A trial (No. 8) was made to test the effect of both chipping and hot water treatment on the seed, the seed being chipped first and then subjected to hot water treatments. By this means, it was hoped to eliminate seed coat interference and to find the effect of the treatments directly on the embryo. The method is open to the criticism that while chipping may tend to remove the seed coat protection, it is not known whether it does so wholly or only partially. Complete removal of the seed coat would have been preferable, but was not practicable. The seed was divided into two lots after treatment, one lot being put to germinate immediately while the other was dried and stored for thirty days before germination. Commercial seed was used and in both cases germination took place in petri dishes at 84°F. The results are summarized in Tables VI and VII.

TABLE VI.

Trial No. 8. Final germination following temperature treatments and periods of storage—commercial seed.

Treatment	Period of storage					
	Germination %			Angle		
	0 days	30 days	Mean	0 days	30 days	Mean
60°C.	86·4	95·6	91·0	69·56	79·85	74·70
80°C.	73·3	95·2	84·2	59·32	77·61	68·48
Boiling point	46·7	88·5	67·6	43·51	71·41	57·46
5 minutes boiling	0·0	6·2	3·1	0·00	11·49	5·75
Mean	51·6	71·4	61·5	43·10	60·09	51·59

	Treatment	*Storage*	*Interaction*
Standard error	1·236	0·874	1·748
Significant difference (P=0·05)	3·49	2·47	4·93
Significant difference (P=0·01)	4·63	3·27	6·53

TABLE VII.

Trial No. 8. Final germination of size groups following periods of storage.

Seed size	Period of storage					
	Germination %			Angle		
	0 days	30 days	Mean	0 days	30 days	Mean
Large	50·3	73·6	61·9	42·06	62·89	52·48
Medium	51·4	72·5	61·9	43·58	61·64	52·61
Small	53·1	68·1	60·6	43·65	55·75	49·70
Mean	51·6	71·4	61·5	43·10	60·09	51·59

	Seed size	*Storage*	*Interaction*
Standard error	1·071	0·874	1·514
Significant difference (P=0·05)	—	2·48	4·27
Significant difference (P=0·01)	—	3·27	—

The marked reduction in germination in this experiment when seed was germinated immediately after treatment indicated that the protection afforded by the seed coat plays an important role in rendering the wattle seed resistant to hot water treatment. At the same time the embryo must have considerable tolerance to heat and it would seem to be this tolerance combined with the protection of the seed coat which determines the seed's ability to stand heat damage. When dry-stored, the seeds showed a high degree of recovery from the adverse effect of treatment. From the interaction between hot water treatment and time of storage, it was evident that this recovery was not the same for all treatments but that, within limits, the more severe the treatment the greater was the recovery. There was also an interaction between seed size and time of storing, due to a greater recovery in large and medium seeds than in small seeds. This interaction, which at first seemed possibly to be fortuitous, was confirmed by a further experiment.

A further trial (No. 9) was made to test the recovery of a sample of commercial seed subjected to a series of treatments ranging from 80°C. to boiling for 4½ hours. After treatment, the seed was washed and dried, and germination tests were made with samples withdrawn after various periods of storage. The results of this trial are shown in Table VIII.

Storage increased the percentage germination in all treatments except at 80°C. The maximum germination following treatment at 90°C. and at boiling point occurred after 15 days storage and showed a drop after 60 days storage. With the severer treatments, the maximum germination was reached after a longer period of storage. The significant interaction showed that, as in Trial No. 8, seed did not respond in the same way to storage after all treatments. The greater percentage increase in germination after the severer treatments accounted for the interaction.

A point of interest is the extreme tolerance of wattle seed to boiling. Protection must be afforded largely by the seed coat since when this was cut, as in Trial 8, the embryo was much more sensitive to hot water treatment.

Discussion.

General. Since leguminous seeds which possess impermeable coats vary, not only in the percentage hard coats from year to year, but also in the degree of hardness within one sample (Barton and Crocker, 1948), it is not surprising that treatment with hot water does not affect all seeds to the same degree. Owing to this variation in hardness, it is practically impossible to treat seed with hot water so that the full potential ger-

mination is realized. Treatment severe enough to render the toughest seed coats permeable may be too severe for the softer coated seeds. In treating any sample of seed with hot water, there is always a tendency to reduce germination either by over-treatment of the sensitive types or under-treatment of the hard types.

TABLE VIII.

Trial No. 9. Germination of commercial seed following varying hot water treatments and periods of storage.

Days storage	Treatment												
	80°C.	90°C.	Blg. point	½ hr. blg.	1 hr. blg.	1½ hr. blg.	2 hr. blg.	2½ hr. blg.	3 hr. blg.	3½ hr. blg.	4 hr. blg.	4½ hr. blg.	Mean
	Germination %												
0	95·0	92·5	91·5	62·0	44·5	27·5	10·5	5·0	0·5	2·0	0·5	0·5	40·3
7	94·5	97·5	94·5	74·0	52·0	40·5	22·0	15·5	7·5	2·0	0·5	0·5	45·4
15	95·0	99·5	98·5	70·5	57·0	35·5	23·5	11·0	7·5	5·5	5·5	1·0	46·5
21	95·0	96·5	95·5	74·4	54·0	41·5	25·0	12·0	8·0	5·0	4·5	1·0	46·3
28	93·5	98·0	96·0	60·5*	49·5*	27·5*	11·5*	7·5*	3·0*	1·0*	0·5*	0·5*	41·6
48	94·5	96·0	94·5	67·5	43·0	32·0	28·0	14·5	9·5	5·5	3·0	2·0	44·7
60	88·0	92·5	89·0	70·0	57·5	38·0	24·0	18·0	8·0	7·0	1·5	1·5	44·8
Mean	93·6	96·1	94·2	68·4	51·1	34·6	20·6	11·9	6·3	4·0	2·3	1·0	44·2
	Angle												
0	77·14	74·64	73·76	52·00	41·79	31·31	17·74	11·04	2·03	6·95	2·03	2·03	35·83
7	77·56	81·02	76·93	59·46	46·22	39·35	27·83	22·92	15·60	8·13	2·03	2·03	40·78
15	79·16	87·97	83·90	57·69	49·04	36·23	28·82	19·18	15·60	13·13	13·26	4·06	43·50
21	79·25	79·31	77·99	59·94	47·31	40·07	29·77	19·72	15·58	12·57	10·63	4·06	42·10
28	75·91	83·05	78·84	51·06	44·66	31·60	18·70	14·57	7·09	4·06	2·03	2·03	37·50
48	76·58	78·65	77·22	55·60	40·24	34·13	31·11	22·21	15·25	11·76	8·46	5·58	40·80
60	69·79	74·13	71·00	56·85	49·32	37·99	29·33	24·86	15·87	14·59	4·92	4·92	40·26
Mean	76·48	79·82	77·09	56·11	45·58	35·81	26·19	19·21	12·43	10·17	6.20	3·53	40·11

* Fungal attack was particularly severe in these treatments.

	Treatment	*Storage*	*Interaction*
Standard error	1·063	0·780	2·813
Significant difference (P=0·05)	2·96	2·17	7·83
Significant difference (P=0·01)	3·90	2·86	10·31

Germination following hot water treatment is not governed solely by the direct effect of the treatment. Three factors appear to be involved in the effect of treatment on germination. First, there is the greater or lesser protection afforded to the embryo arising from the differential sensitiveness of the seed coat. Secondly, hot water treatment has a detrimental effect on the embryo, delaying germination or, in severe cases, preventing growth. This effect is complex, depending apparently not only on the protection afforded by the seed coat, but also upon some intrinsic property of the embryo also.

It is further complicated by the fact that, under suitable conditions, seeds whose germination has been delayed by treatment can recover and the embryo resume normal growth. Thirdly, there is the effect of external conditions on seeds which have been damaged to a greater or lesser extent by treatment. Hot water treatment renders the seed coat very susceptible to attack by fungi and bacteria. The more drastic the treatment the greater is this susceptibility and, at the same time, the weaker has the embryo become. Under favourable conditions, attack by fungi and bacteria may spread to the weakened embryo. The primary effect of treatment may, therefore, be accentuated by external conditions. It is considered that this factor largely accounts for some of the inconsistent results from germination trials. Germination tests made in cool weather during the winter, when attack by fungi and bacteria was not likely to be so rapid or heavy, showed little difference between the size groups because seeds had time to recover from treatment. In summer or under warm conditions, the rapid growth of fungi and bacteria did not give damaged embryos the opportunity to recover. One important point which emerged was that this differential effect may occur when hot water treated seeds are planted normally in the soil.

Possible genetical effects. If the distribution of seed coats varying in degree of hardness had no genetical significance and were at random over the whole seed sample, then elimination of the sensitive types by treatment would reduce germination without altering the proportions of genetical types remaining capable of germination. It has been shown, however, that the more sensitive seed coats occur chiefly amongst the larger seeds. This leads, under some circumstances, to a greater proportion of large seed than other types being destroyed by treatment, leaving a seed population capable of germination which has a different size distribution from the original sample. If, therefore, sensitivity of the seed coat or seed size were controlled by genetical factors, then the full range of genetical types would not always appear following hot water treatment. It is not known whether differences in degree of hardness of the seed coat in black wattle are controlled by genetical factors, but there is some evidence in other legumes that this is the case (Hübner, 1938; Shain, 1947). Again, it has not been established definitely that seed size is controlled by hereditary factors. It has been shown, however, that individual trees of green wattle (*A. decurrens*) differ significantly from each other as regards seed size (Philp and Sherry, 1946) and the writer has found significant differences in seed size between individual trees of black wattle. The implication is that both hardness of seed coat and seed size are governed, to some extent at least, by genetical factors. It remains to determine whether such seeds from a tree producing large seeds are, on the whole, more sensitive to treatment than those from trees producing small seeds. The Osborns (1931) have shown that individual trees of black wattle do differ in their sensitiveness to treatment, but the relative seed sizes were not determined.

On the evidence, it seems probable that seed coat hardness and seed size are governed by genetical factors and that these factors may be subjected to a selective force by hot water treatment. Selection will, however, not only affect these gene combinations, but through correlated responses due to linkage, will cause changes in combinations affecting other characters for which no selection is practised (Mather and Harrison, 1949). It is impossible to say at this stage what the nature of these correlated responses would be or how they would affect wattle breeding, but such selective forces should be recognized where genetical investigation is in progress. Concerning the apparent deficiency of twin seedlings which prompted the investigation, it seems probable from information coming to hand after the commencement of the trials, that the lack of twins was due to a general depression in germination following hot water treatment. Randall and Rich (1945) and earlier workers, have shown that when the overall germination was below normal, there was an associated deficiency of twin seedlings.

Recovery of seed after treatment. The gradual recovery of seed from treatment presents problems of physiological interest apart from its practical importance. The Osborns (*loc. cit.*) found that when wattle seed was kept up to two months after treatment, not only was the germination higher, but measurements on the length of hypocotyl

showed that growth was more rapid. The conclusions reached were that, " It appears to be quite evident that the treatment of seed with boiling water not only renders the seed coat permeable, but it must also set in action certain physiological changes within the seed which cause seed treated at an earlier date to germinate more rapidly." From comparison with chipped seed, however, it is more likely that the effect of boiling water is not stimulating, but that it slows down the growth of the embryo and that the more rapid germination after storage is a gradual return to normal rather than a speeding up process. The behaviour suggests that some substance such as an enzyme is partially destroyed and must be replaced before the normal speed of germination is regained. The difference in recovery of large and small seeds reported in Trial No. 9 is, at the moment, inexplicable.

Practical applications. Two views may be taken of the practical applications of the investigations on seed germination, that of the geneticist anxious that every possible seedling should survive and that of the commercial planter also anxious to obtain high germination, but less interested in the fate of each individual seed.

From the genetical point of view, hot water treatment is unsatisfactory. The full germination potential of the seed is rarely realized and, at the same time, the seed is subjected to a strong selective force with unpredictable results. Germination is erratic, extending over a period of three weeks or longer after the first seedling has appeared above the soil. The alternative method of rendering the seed permeable by chipping the seed coat has proved satisfactory for genetical material. The method is somewhat laborious, but nevertheless is perfectly feasible for the comparatively small numbers of seeds required for genetical investigation. During the present season, some 8,000 seeds of selfed and natural progenies of black wattle have been rendered permeable by chipping, with excellent results. In families with good seed, the germination percentage was high and all viable seeds appeared above the ground within two or three days of each other. This uniform germination greatly facilitated comparative observations and the scoring of seedling characters. By treatment at 90°C., germination percentages closely approaching those of chipped seed can be obtained, but the erratic germination is still a disadvantage.

From the commercial point of view, chipping, or some similar process, is not feasible at the moment and seed must still be treated with hot water. The optimum temperature for treatment is below boiling point, probably somewhere in the neighbourhood of 90°C., while even at 80°C. a high germination will result. Any prolongation of the boiling treatment is detrimental, resulting in an immediate reduction in germination. From the results of the experiments on the recovery of seed from treatment, it would seem that seed should be treated and then dried and stored for at least two weeks before sowing to allow this recovery to take place.

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NOTES ON INSECTS OBSERVED DURING THE PERIOD 1949 - 1952

By L. L. J. OSSOWSKI

An account is given of the wattle insects observed during 1949-52. Special mention is made of wattle bagworm and the gradation of its infestation in 1951-2. Parasites and predators of wattle insects are listed.

Except for those concerning wattle bagworm, no continuous records are available on the occurrence and epidemiology of wattle insect pests. Such records, however, are essential for the early prediction of outbreaks and the timely application of preventive and protective measures. The present paper comprises a record covering the past four years and will be continued annually in future Reports.

Few wattle insects have common English names and such names as are in use are often inaccurate and misleading. In some cases, therefore, new and more appropriate common names are suggested in the hope that these will be accepted and become well known. The insects are listed by natural orders and families, the proposed new common names being denoted by asterisks.

I. ORDER : LEPIDOPTERA.

Family : *Psychidae.*

1. *Wattle Bagworm,* Acanthopsyche junodi *Heyl.*

The wattle bagworm is an insect native to Southern Africa, where its natural host plants are the thorn bushes consisting of various species of *Acacia,* from which it invades cultivated wattles. This insect is the commonest and most destructive of all wattle pests.

The building up of an infestation, which seems to require 5 to 7 years to reach its peak, after which it returns to normal, depends on climatic and other factors. A normal year, *i.e,* when there are practically no bagworms in the plantation, is usually followed by 2 years of the initial stage, when bagworms become more abundant. After that, the infestation enters the prodromal stage which, as a rule, lasts 2 years during which the bagworm population increases rapidly and damage becomes evident. Then follows the eruptive stage, which may last from 1 to 3 years. Trees are completely defoliated and bagworms are prone to disease and may also die from lack of food. If complete defoliation occurs 2 years in succession, many trees die, especially when growing on poorer quality sites and in drier parts of the country. The eruptive stage is succeeded by the crisis and then an abatement of the infestation takes place.

In the season of 1951-2, some 40,000 acres of wattles were infested with bagworms and out of these, nearly 7,000 acres showed almost complete defoliation. The main centres of infestation were in the Vryheid, Kranskop, Greytown, and Harding areas. In the three last-named districts, the peak of the gradation is expected not earlier than between 1953 and 1955. Smaller pockets of infestation were found during 1951-2 at Hilton and Table Mountain, and also around Lion's River and New Hanover, where the infestation has entered the second year of its prodromal stage. An infestation appears to be building up in the Wartburg district, where at present some 2,000 acres of wattles are lightly infested. In the Melmoth district, a light infestation is increasing over an area of some 5,000 acres. In the north-eastern part of the Kranskop area, around Redgate, and in the Richmond district, the peak was reached in 1950-1 and the abatement which followed was due mainly to white fungus, *Isaria psychidae* Pole

Evans. The wattle plantations around Piet Retief have very few bagworms at present, though in one area near Iswepe, these insects have increased in the last season from 0·2 to 1·2 per tree, which indicates that the bagworm population there is building up and has entered the first year of its initial stage. In the vicinity of Alma, near Piet Retief, approximately fifty acres show a moderate infestation.

Apart from *Isaria*, polyhedral wilt and entomophtora (brown) fungus are responsible for bagworm mortality. The commonest insect parasite of the bagworm is an ichneumon, *Philopsyche abdominalis* Morley. The tachinid fly, *Carcelia evolans* Wied., on which a hyperparasite belonging to the *Eurytoma* genus was found, is also fairly prevalent on bagworms. Other parasites found and reared by this Institute during the time under report were :

Diptera :
Tachina fasciata segregata Rond.

Hymenoptera :
Tetrastichus sp.

Coleoptera :
Diphyllus clavatus Arr., hitherto thought to be a fungus feeder.
Larvae of the family *Cleridae*, genus *Opilio* or a related genus.

Psocoptera :
Caecilius sp.
Ectopsocus sp.
Lachesilla sp.

The following arachnids were found preying on bagworms :

Argyopidae :
Araneus nigropunctatus Lawrence.
Araneus strupifer Simon.

Clubionidae :
Clubiona silvicolum Lawrence.
Clubiona pupilaris Lawrence.
Chiracanthium sp.

Thomisidae :
Synaema imitator Pav.

Salticidae :
Evophrys sp.
Menemerus sp.
Another salticid species of unknown genus.

2. *Lictor Bagworm,* Clania moddermanni (*Heyl.*).

The bag of this species differs from that of the wattle bagworm in that it consists of small sticks rounded off at both ends and attached lengthwise to the bag. The sticks are not all equally long and usually two extend for a considerable distance beyond the bag, most probably to protect the insect from being pulled out by birds or other enemies. While in the adult female of the wattle bagworm all vestiges of legs have disappeared, the legs of the adult female of the lictor bagworm are rudimentary, being represented by forked, membraneous appendages of the thorax.

The lictor bagworm has become more abundant in recent years and in some young wattle plantations, where hand-picking was carried out as a preventive measure, up to fifteen per cent. of the bagworms collected were of this species. This insect has recently been infiltrating into wattle plantations, not only in this country, but also in the recently-established wattle plantations of Southern Rhodesia.

This species is easier to control than the wattle bagworm, since it usually feeds on younger trees, and if on older ones, mainly on the outside branches and in the lower parts of the tree. Thus it can easily be collected by hand.

Family : *Cossidae.*

3. *Crossed-stick Bagworm,* Gymnelema vinctus (*Wlk.*).

This bagworm, though quite common in wattle plantations, is not a serious wattle pest, since it feeds mainly on grass and wattle undergrowth and it is very seldom to be found on older trees. The bag of this species is built of grass, little twigs, or the midribs of leaves which are fastened, at approximately their middle, tangentially to the casings. Each stick crosses over the end of the preceding one and the whole bag assumes a pentagonal form, the diameter of the bag increasing towards its upper part. Both sexes of this species are fully-developed, positively phototactic moths which fly mainly at night.

Family : *Lasiocampidae.*

4. *Small Wattle Lappet Moth,** Anadiasia punctifascia *Wlk.*

This insect is very common in wattle plantations and seems to be more abundant during wet seasons. The larvae are gregarious, clustering together in the daytime and spreading over the tree at night for feeding. Their hairs cause irritation to the human skin. There are two generations in one year and damage done to younger wattle trees is considerable, especially during the summer and early autumn, when the larvae are feeding for some three months.

The pupae are parasitized by *Sturmia* (*Prosturmia*) *idonea* B.B., and the larvae by a species of *Charops*, which pupates outside its host in a greyish barrel-shaped cocoon attached to the bark of the tree by means of a thin silky thread. This strand consists of several fibres which arise from the centre of the cocoon. A shield bug, *Glypsus maestus* Germ., is predaceous upon all larval instars.

Severe outbreaks of this pest were recorded in 1949 in plantations in the Wartburg district and also around Kranskop. Larvae were abundant in 1950 in plantations at Broadmoor, near Wartburg, and also at Henley Dam, Pietermaritzburg. In 1951, they were more noticeable in the Table Mountain district than in previous years.

5. *Grey Wattle Lappet Moth,* Pachypasa truncata *Wlk.*

This moth is widespread throughout the wattle belt generally, but is usually more abundant during or after a wet season. The larvae, like those of the lesser wattle lappet moth, are gregarious and feed at night. Their hairs cause less irritation to the human skin. There are two generations in each year, and since the larvae are larger than those of *Anadiasia*, the damage done by these insects is considerable since they also defoliate bigger trees.

The following parasites were found on larvae : *Tachina* (*Podotachina*) *sorbillans* Wied. and *Sturmia* (*Prosturmia*) *idonea* B.B. Polyhedral wilt can also cause high mortality.

Severe outbreaks of this pest were recorded in 1950 in plantations near Pietermaritzburg, around Kranskop, and in the Ahrens district. In 1951, an infestation recurred in the Ahrens district, and larvae were more abundant in the Table Mountain, Spring Grove, Wartburg, Vryheid, and Iswepe districts.

6. *The Large Wattle Lappet Moth,** Gonometa postica *Wlk.*

This insect has only one generation in a year and the adult is on the wing around October. The larvae, which are solitary feeders, are of a very conspicuous mingled black and yellow colour.

The following parasites were found on pupae : *Sturmia* (*Prosturmia*) *patruelis* Mesnil 1949 and a so-far undescribed *Brachymeria* species. The Director of the Commonwealth Institute of Entomology states (*in lit.*) that the British Museum has specimens of the last-named species from Zululand *ex Acanthopsyche junodi* Heyl.

A severe outbreak was recorded in 1951 in plantations at Cramond in the Albert Falls district and in plantations near Greytown.

7. Pseudometa dollmanni *Tams.*

An abundance of this lasiocampid, which has been recorded as feeding on msasa, *Brachystegia Rondii* Baker F., and other indigenous trees of Southern Rhodesia, occurred in 1949-50 in wattle plantations in the higher wattle belt of Southern Rhodesia in the Inyanga district. Approximately 300 acres of wattles were infested, of which thirty acres were completely defoliated. No recurrence of this pest has so far taken place.

Family : *Saturniidae.*

8. *Silver-spined Wattle Caterpillar or Wattle Emperor Moth,** Gynanisa maja (Klug).

This species is fairly common, especially in younger wattle plantations. Since the larvae are voracious feeders, the damage done by defoliating smaller wattle trees is considerable. According to records of the Natal Museum, plantations near Pietermaritzburg were defoliated in 1914 and 1932. The larvae were abundant in 1950 and 1951 in the Table Mountain district and near Kranskop. A large number of wattles up to 15 feet high were completely defoliated.

There are two generations in one year. After the second moult, the larvae are of a very conspicuous grass-green or emerald-green colour, which becomes bluish-green with the approach of pupation. The larvae have four main rows of *scoli,* which are silvery on the outer and yellowish on the inner sides. The mortality of larvae when overcrowded is very high, especially in the later instars, and is mainly due to a disease which causes drying up and ultimate mummification of the larvae. Polyhedral wilt is less prevalent, though it was observed in the Table Mountain district in 1951 on larvae of the fourth instar. A fairly common braconid parasite, *Apanteles maculitarsis* Cram., which occurs also on other saturnids, especially on the Pine Tree Emperor Moth, *Nudaurelia cytherea capensis* Stoll., was found to cause a high mortality in 1950 and 1951. Larvae infested with this parasite are retarded in growth and never reach maturity.

9. *Willow Tree Caterpillar or Willow Tree Emperor Moth,** Gonimbrasia tyrrhea *Cram.*

This saturnid was first reported in 1891-2, having been observed feeding on wattles at Beaufort West (Hardenberg, 1912). At present, it is a major wattle pest in the Transkei, where defoliation is reported from Cofimvaba and Ibeka, and where for the last three years wattle plantations have been infested over a considerable area. In 1949-50, there was a light infestation over approximately 100 acres; in 1950-1, approximately 250 acres were defoliated, and the area increased in 1951-2 to nearly 700 acres.

In 1951-2 larvae of the later instars were heavily parasitized with a braconid parasite, *Apanteles aethiopicus* Wilkinson.

10. *Pale Wattle Saturnid,* Heniocha appolonia (*Cram.*).

This moth is found generally in wattle plantations, but is never very abundant and is not regarded as a potential wattle pest.

11. Nudaurelia wahlbergi *Boisd.*

The host plants of this saturnid are mainly *Trema guineensis* (Schum.) (=*bracteolata* L.), *Ricinus communis* L., and other small trees and shrubs (Platt, 1921). Lately this insect has done considerable damage to the American sweet gum, *Liquidambar styraciflua* L., in gardens in Pietermaritzburg and also at Broadmoor. In the last-named place, the larvae also invaded some wattles growing in the vicinity of the infested garden. A few wattles were defoliated, but in general this insect is so far not regarded as a wattle pest. The braconid parasite, *Apanteles aethiopicus,* was found frequently on larvae of the last two instars.

Family: *Noctuidae.*

12. *Fruit-piercing Moth, Wattle Looper, or Wattle Noctuid,** Achaea lienardi *Boisd.*

This noctuid was reported in 1871 in the Hill Crest district, where it was observed

to damage pastures and indigenous bush. Outbreaks recurred in that area in 1915, in 1940-1 when approximately 200 acres of wattle were defoliated, and in 1948-9 when complete defoliation of 50 acres resulted. Larvae were also abundant there in 1951-2, but did not do much damage since they died in their earlier instars of an unknown disease. A heavy infestation took place in 1936 in Zululand, where some 400 acres of wattle were attacked, of which 150 acres at Boegoenek in the Melmoth district were completely defoliated, and, therefore, difficult to strip. This insect was also reported to be abundant in 1938 in the Paddock area, where an outbreak coincided with an attack of wattle webworm (Ripley, Hepburn, Petty and Dick, 1939). According to a former Forest Research Officer in Pietermaritzburg, a severe infestation was experienced in 1940-1 at Harburg, where some 800 acres were completely defoliated. A light outbreak was noticed in 1950 in one block at Bloemendal and in two plantations near Table Mountain. The damage done was negligible. Adults were abundant in 1951 and 1952 at Bloemendal and some other plantations near the Pietermaritzburg-Wartburg road, but no damage was noticeable. A plantation near Umzinto showed an increase of larvae of this pest in 1951-2, and the damage there was considerable, since the attack coincided with an outbreak of wattle webworm and small wattle chafer beetle.

The wattle noctuid occurring in the wattle belt has usually only one generation per year, but under favourable climatic conditions, there may be two or more.

It was noticed that the colour of all solitary larvae was white, whitish, or pink, while the crowded caterpillars (phase *gregaria*), were light brown, brown, or black.

Family: *Arctiidae.*

Two species of this family are very often to be seen in wattle plantations, especially on younger trees, but so far, no damage done by larvae has been reported. The species are :

13. *The Black Woolly Bear,* Diacrisia lutescens Wlk., and

14. *The Brown Woolly Bear,* Diacrisia eurographica Wlk.

Family : *Tortricidae.*

15. *Wattle Webworm or Wattle Lief Tier,* Polychrosis incultana Wlk.

The wattle webworm, once unknown in wattle plantations, first became abundant in 1938-9 in the Cramond-Albert Falls district and in the following year at Hill Crest and Paddock (Ripley *et al.*, 1939).

There seem to be several generations at intervals of approximately four weeks during the summer and early autumn months. The November/December generation seems to produce the largest progeny. The larvae feed without leaving the very conspicuous nest, which consists of leaves fastened together with silk. The damage done is frequently quite serious, especially since an outbreak of this pest usually coincides with an attack of " froghopper " jassids and capsids. A severe outbreak occurred in 1949-50 at Hill Crest, together with a heavy froghopper infestation, and plantations over an area of approximately 250 acres were extensively damaged. In all, some 25 acres of wattles died as a result of the combined damage. The webworm infestation recurred at Hill Crest in 1951-2, but the damage was not very severe and the trees have recovered. Webworm was also prevalent in 1951-2 in young wattle plantations near Umzinto and coincided there with a light outbreak of wattle noctuid and *Monochelus*, and the damage done by these three insects together was considerable. No parasites were found on webworm during the 1949-50 outbreak. The presence of two hymenopterous parasites and one dipterous parasite (not further specified) was reported during the outbreak in 1937-8 (Ripley *et al.*, 1939).

II. ORDER: COLEOPTERA.

Family: *Scarabaeidae.*

16. *Large Wattle Chafer Beetle,* Hypopholis sommeri *Burm.*

This beetle, well known and widespread throughout the wattle belt, appears from time to time in larger numbers and the damage it causes becomes serious. The larvae, commonly known as "white grubs," cause the most serious damage by gnawing the roots of young seedlings and of somewhat older trees. There is one generation per year and the adults are on the wing during the early summer months. Severe damage caused by adults was reported in 1949-50 and in 1950-1 from the Spring Grove area and in 1951-2 from the Seven Oaks and Hilton Road districts. In the latter, some 400 acres were infested and approximately 60 acres of young plantations were completely defoliated.

There is evidence that the hadedah ibis, *Hagedashia hagedash hagedash* (Latham), is instrumental in keeping this pest in check. The digestive organs of thirty-one dissected hadedahs contained fragments representing 1,906 insects, of which 605, or over thirty-one per cent., belonged to the family *Scarabaeidae.* The gut of one bird alone contained 132 scarabaeids (Ossowski, 1952).

17. *Wattle Beetle or Kaffir Chafer Beetle,** Anomala caffra *Burm.*

This wattle beetle, which appears to have the same life cycle as the large wattle beetle, is also fairly abundant in wattle plantations, and the damage is similar to that caused by the former. An outbreak of this pest was reported in 1951-2 in the Seven Oaks district.

18. *Small Wattle Chafer Beetle,* Monochelus calcaratus *Burm.*

The small wattle chafer beetle is well established and very widely distributed in the Midlands of Natal and the south-eastern part of the wattle belt. An outbreak usually occurs together with one or both of the above-mentioned beetles. *Monochelus* was prevalent in 1949-50 in the Spring Grove area and other outbreaks were reported in 1951-2 from plantations near Seven Oaks and also from the Ixopo and Harding areas.

19. *Mashonaland or Rhodesian Cockchafer,** Eulepida mashona *Arrow.*

The larvae of this beetle, hitherto supposed in Rhodesia to attack only tobacco, tomatoes, mealies, and other arable crops, have lately damaged wattle plantations also, gnawing the roots of trees up to 12 feet high, and wiping out plantations over considerable areas. The wattle area invaded by this pest amounts to several thousand acres and the damage done is disastrous. The outbreak of this pest in wattle was first noticed in 1949 and since then has recurred year after year with undiminished severity. Investigations into the bionomy of this beetle indicate that the life cycle occupies 1 year. The adults emerge around November and copulation takes place almost immediately afterwards. Development of the eggs occupies 21 days and each female deposits up to 60 in the soil at depths up to 10 inches. The larvae, which hatch 14 to 18 days after oviposition, moult 4 to 5 times and reach their full growth during the early winter months when they are approximately 2 inches × 0.6 inch. They feed till about the end of June and afterwards penetrate deeper into the soil where they pupate in earthen cells resembling crumbled earth. Adult beetles have been recorded as feeding mainly on foliage of indigenous trees, especially msasa, mnondo, *Isoberlinia globiflora* Hock, *Gardenia,* and other native species. Thus far the beetles have not penetrated very deeply into wattle plantations in search of food, and have been found to feed on wattles only sporadically.

Only one tachinid cocoon of a *Dexia* species was found in one larva, but a large number of larvae died as a result of attack by a fungus of the genus *Cordyceps* Fries.

Two smaller chafer beetles also are to be found in the lower wattle belt of Southern Rhodesia. The damage done by these insects in wattles is, however, negligible and so far they are not regarded as a potential wattle pest. These beetles are :

20. *The Shiny Chafer Beetle,** Anomala resplendens *Fahr.*, and

21. Anomala *sp. nr.* pinguis *Pering.*

Family : *Cerambicydae.*

22. *Red-banded Longhorn Beetle,* Pycnopsis brachyptera *Thoms.*

The adults of this longhorn beetle can cause serious damage in young wattle plantations by feeding on the succulent bark. They mainly attack the thinner top part of the tree, in consequence of which, tops are broken by wind and crowns become bushy and deformed. Ring-barking has also been observed.

Considerable damage was noticed in 1950 in plantations in the Albert Falls district and in 1951 and 1952 in younger plantations near Kranskop, Bloemendal, and below Table Mountain.

It is difficult to observe adults feeding since any slight movement in their vicinity causes them to drop to the ground and sham death. Being well camouflaged, they are not easily detected on the ground among grass and litter.

III. ORDER : HEMIPTERA.

Wattles are attacked by two species of this order known under the collective name " froghopper." These sucking insects, being light-loving, tend to gather on tops of trees, where they damage young shoots, causing much branching and temporary cessation of height growth.

Family : *Jassidae* (*Cicadellidae*).

23. *Large Green Jassid,* Bythoscopus cedaranus *Naudé.*

This insect can be found the whole year round in all stages on young wattle trees, but is most common during the summer months. The main damage is done by the November/December generation, but damage becomes noticeable only the following March/April.

Several outbreaks were experienced in 1949-50 and in 1951-2 over large areas in plantations around Seven Oaks and Hill Crest.

Family : *Capsidae.*

24. (*Brown*) *Capsid,* Lygidolon laevigatum *Reut.*

The habits of this insect and also the damage done by it are identical with those of the green jassid. The life cycle of the capsid, however, seems to be somewhat different and it appears to have fewer generations in one season than the jassid.

IV. ORDER : THYSANOPTERA.

Family : *Thripidae.*

25. *Citrus Thrips,* Scirtothrips aurantii *Faure.*

This insect is primarily a citrus pest, but other host plants such as eucalypts and acacias have been reported (Bedford, 1943). In 1951-2, some 600 acres of green wattle, *Acacia decurrens* Willd., were badly damaged by this insect in Cramond, and it is estimated that a whole year's increment was lost. The attack started in December and damage in the form of brown and wilted crowns became visible during the autumn and winter

months. It may be mentioned that black wattles interplanted with the green wattles were not damaged by these insects, though the thrips was equally abundant on both species. Green wattles appear to be both food and host plants, while black wattles, the leaves of which are more pubescent than those of green wattles, seem to be food plants only, in which thrips apparently cannot oviposit.

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A COMPARISON OF THE SIZE OF DROPLETS IN OIL FOGS

By P. E. METCALF and L. L. J. OSSOWSKI

A portable, insecticidal fog generator, the " Kyoritu," was used to test whether there was any relationship between the size of the droplets in an oil fog and the viscosity of the oil. The experimental technique, using slides coated with magnesium oxide, is described. No significant difference was revealed in droplet size between the fogs from four different oils, though there is an indication that the greater the viscosity of the oil the larger are the droplets in the fog. The " Kyoritu " machine was found to produce fogs with a wide range in droplet size, and this may account for the failure of the experiments to reveal a significant viscosity effect. The fog-sampling technique appears to be satisfactory and the procedure as a whole offers promise of a useful method for comparing the performance of fog-producing machines.

Introduction.

In 1951, a small, portable, insecticidal fog generator, made by Kyoritu Noki Kaisha Ltd., Tokyo, Japan, was acquired by the Wattle Research Institute and has since been used against the wattle bagworm, froghopper, chafer beetles (*Eulepida mashona*, Arrow), and army worms (*Laphygma exempta*). The insecticides used were BHC and Toxaphene, and results obtained have been promising.

When using different oils as solvents for the insecticide, it was noticed that the density of the fog obtained varied greatly. It was thought that this might be due to differences in droplet size of oils of different viscosities and the following experiments were carried out to test this hypothesis. Such information is desirable since, within limits, the smaller the droplets the better the cover obtained. Of the two experiments, the first was of an exploratory nature and will not be reported in detail.

Materials and Equipment.

The four oils used were Shell Diesoline, Shell Diesel Fuel, Shell Carnea Oil 21, and B.P. Furnace Fuel, with respective specified viscosities of 33, 40, 97, and 46 seconds Redwood I at 100°F.

In the Kyoritu machine used in these experiments, a single-cylinder, 4-stroke petrol engine drives a small pump which forces a fine jet of insecticide into the conversion chamber where it is vaporized as it meets the exhaust stream from the engine. A needle valve controls the rate at which the insecticide is pumped into the conversion chamber. Surrounding the outlet from the conversion chamber is a large tube through which a fan drives a strong current of air to propel the fog.

Glass microscope slides, coated on one surface with magnesium oxide (May, 1945), were used to collect fog droplets. For each application of an oil in the first experiment, nine of these prepared slides were fixed by means of spring clothes-pegs to each of two stream-lined wooden frames placed at 25 feet and 40 feet respectively from the fog machine. Four slides, on a single frame placed 30 feet from the fog machine, were used in the second experiment.

Method.

By conducting the experiments in an empty aircraft hangar, interference with the fog by the prevailing light breezes was minimized.

After the slides had been attached to the frames with their coated surfaces facing the path of the fog, the machine, charged with the oil to be tested, was run for about

a minute outside the hangar to check its performance and to remove residual oil from the insecticide pump and the connecting tubes. The machine was then returned to the hangar and fog was projected at the frames for about 20 seconds.

Besides an attempt to achieve a strictly constant direction of the fog stream throughout, the second experiment differed from the first in that the temperature of the fog machine was taken into account. The bulb of a thermometer was bound on to the outer surface of the conversion chamber, the stem of the thermometer being held between cork to reduce vibration. When the temperature reached 145°C., the needle valve was opened to a pre-determined position for 15 seconds. During this period, the thermometer reading dropped by about six degrees, irrespective of the nature of the test oil. In addition, in the second experiment, the same time-interval was observed between applications of the various oils and special care was exercised to keep the speed of the engine as nearly constant as possible.

In order to minimize sequence effects, it was decided that the order of application of the test oils should follow a latin square design. A single systematic latin square of the diagonal type was used in the first experiment, whilst two randomized latin squares were used in the second.

As the droplets impinged on the prepared surfaces of the slides, they formed stable craters, the diameters of which could be measured with accuracy using a 10x objective and 6x micrometer ocular with an ordinary microscope. By using glancing surface illumination of high intensity, the craters were revealed very satisfactorily, as is shown in Fig. 1. It will be seen that the outlines are quite distinct, even where they overlap.

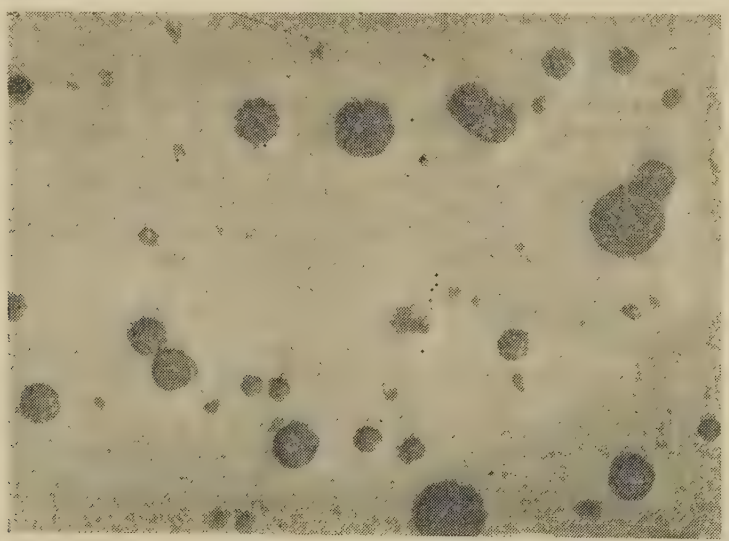

Fig. 1.—*A typical group of craters produced by oil droplets impinging on a magnesium oxide surface* (magnification 50 times).

In both experiments, the diameters of five craters, chosen at random from an area of 1 cm. square on each slide, were measured. In the first experiment, the sampling area was approximately in the centre of the slide ; in the second, samples were taken close to the free edge of the slides to minimize possible eddy effects.

The method adopted for the random choice of droplets was as follows. Ten markings, suitably located on each scale of the mechnical stage of the microscope, were selected and to each was ascribed a digit from 0 to 9. A two-digit number was taken from a table of random numbers and the separate digits used as co-ordinates to fix the position of the slide. The diameter of the crater nearest the centre of the field was then measured to the nearest half unit of the ocular micrometer scale.

Results.

Experiement No. 1.

The results of this experiment are summarized in Table I.

TABLE I.

Mean diameters in μ of droplets, Experiment 1

	Diesoline	Diesel Fuel	Carnea Oil	Furnace Fuel
25 ft. distance	60·0625	60·7507	63·8507	65·7030
40 ft. distance	51·1934	53·2596	56·7036	56·5750
Both distances	55·6280	57·0059	60·2780	61·1398

General mean diameter 58.5125μ
Standard error of a single diameter (as a percentage of the mean).. 61·32%
Standard error between slides (as a percentage of the mean) .. .. 71·68%

Analysis of these results reveals no significant difference between the droplet size of the various oils, though it may be shown that, irrespective of the nature of the oil, droplets are significantly smaller at 40 feet from the fog machine than at 25 feet. A very high experimental error is revealed. This may be due, in part, to the systematic nature of the design, though significance of the replications mean square indicates that the use of the latin square has reduced error to some extent. The variation between the mean diameters measured on slides occupying the same position at the same distance from the machine, and which are treated with the same oil, is very high, as is the standard error of a single diameter.

Experiment No. 2.

Table II presents the results of this experiment in a summarized form.

TABLE II.

Mean diameters in μ of droplets, Experiment 2

	Diesoline	Diesel Fuel	Carnea Oil	Furnace Fuel
First latin square	52·7250	45·6000	64·7178	54·0322
Second latin square ..	52·4875	61·7500	60·0875	64·8375
Combined latin squares ..	52·6072	53·6750	62·4036	59·4339

General mean diameter .. .. 57·0304μ
Standard error of a single diameter (as a percentage of the mean) 59·70%
Standard error between slides (as a percentage of the mean) .. 56·44%

Again, no significant difference is shown between the size of the droplets of the various oils. The experimental error is not nearly as great as in the first experiment, probably due to the greater number of applications and the randomization of the design. The standard error of the mean diameter for slides occupying the same position on the frame and receiving the same treatment has decreased from 71·68 per cent. to 56·44

per cent. of the general mean, yet the standard error of a single diameter is very similar to that encountered in the first experiment.

Table III records the specified viscosities of the oils and the mean diameters of the droplets as determined in the second experiment.

TABLE III.

Viscosities and mean droplet diameters

	Diesoline	Diesel Fuel	Carnea Oil	Furnace Fuel
Viscosity, secs. Red. I at 100°F.	33	40	97	46
Mean diamter, μ	52·6072	53·6750	62·4036	59·4339

These figures reveal an apparently strong correlation coefficient of 0·8609 which, however, cannot be proved significant owing to the small number of degrees of freedom available. If a linear regression line of diameter on viscosity is fitted to the data, the mean square for the regression is not found to be significantly different from the deviations mean square. Consequently, no simple relationship between droplet diameter and viscosity is revealed by the experiment.

Discussion and Conclusions.

In comparing the results obtained in the two experiments, it is particularly interesting to notice that the difference between the general mean droplet diameters is only 1·4821μ, or 2·57 per cent. of the average of the two general means. Also, there is a remarkable similarity between the standard errors of single diameters in the two experiments (61·32 per cent. in the first experiment ; 59·70 per cent. in the second). These two features of the results of two independent experiments suggest that it is a property of this particular fog machine to produce droplets of a wide range of size under the conditions of the experiment, a characteristic which is illustrated in Fig. 1.

Unless means can be devised to reduce this variation appreciably, this type of fog machine must be considered as unsuitable for further experiments designed to compare the droplet size of different oil fogs. Although the present experiments have failed to demonstrate a significant relationship between the viscosity of the test oil and the size of its droplets, the absence of such a relationship is by no means established. On the basis of the results of the second experiment, there are indications in favour of using Diesoline as a solvent for insecticides rather than, say, Carnea Oil 21, since the former oil appears to break up into smaller droplets on average than the latter and should, therefore, give a better cover.

The adoption of a more rigid procedure in applying the oils in the second experiment, coupled with an increase in the number of applications of each oil and randomization of the latin square design, appears to have reduced the experimental error considerably. The improved technique, therefore, may prove to be a simple and satisfactory means of comparing oil fogs of the type used in the field.

It has been assumed that the diameter of the crater formed by a droplet is the same as the spherical diameter of that droplet. No attempt has been made to test this assumption, since *relative* size rather than *absolute* size was the point of importance in this investigation.

These experiments are not regarded as complete, nor is the non-significance of a number of the results considered to be conclusive. Further, it is planned to make use of the technique, which appears to hold much promise, to compare the efficiency of different types of fog generators as well as the suitability of different oils as solvents for insecticides.

Acknowledgments.

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GROWERS' BULLETINS

GENERAL ENVIRONMENTAL REQUIREMENTS FOR COMMERCIAL CULTIVATION OF BLACK WATTLE IN SOUTH AFRICA

By S. P. SHERRY

Wattle Growing Areas of the Union.

It has been found that black wattle grows most successfully in plantation form in the so-called " mist-belt " areas of the summer rainfall zone of the Union.

These areas are located along the escarpments which run parallel to the eastern coastline and on the higher portions of the plateaux which lie between the coastal hills and the principal mountain ranges further inland. The portions of these areas suitable for wattle growing on a commercial scale range in elevation from 2,000 to 4,500 feet above sea level, are not subject to severe frosts, and have an average annual rainfall of 35 inches or more, the greater proportion of which falls between September and May.

The localities in which such conditions are to be found are

(*a*) along the southern slopes of the Amatola Mountains between Alice and Stutterheim in the Eastern Cape Province ;

(*b*) limited areas throughout the main plateau and on southern and eastern escarpments in the Transkei and in Pondoland ;

(*c*) on successive escarpments with suitable aspect and on the higher portions of the intervening plateaux in the zone between the Umtamvuna and Tugela Rivers from points near the coast with altitudes of 2,000 feet to points along the Ingeli Mountain, the foothills of the Southern Drakensberg, and the Karkloof and Blinkwater Ranges at altitudes not exceeding 4,500 feet above sea-level ;

(*d*) limited areas on escarpments with suitable aspect in the vicinity of Vryheid and Paulpietersburg in Northern Natal ;

(*e*) portions of the highlands of Zululand in the vicinity of Qudeni, Nkandhla, Ngomi, and Melmoth ;

(*f*) the highlands of Swaziland ;

(*g*) portions of the undulating highveld country of the South-eastern Transvaal, immediately to the west of the Swaziland border, between Commondale in the south and Panbult, Amsterdam, and Lothair in the north ;

(*h*) on the eastern escarpment of the Berg throughout the Eastern and North-eastern Transvaal.

There are, in addition, a few limited areas outside the summer rainfall zone, in the coastal belt between Port Elizabeth and Cape Town, in which wattle is grown commercially on a small scale.

Altitude Limitations.

In the summer rainfall zone, wattle will grow at altitudes ranging from about 100 feet to over 5,000 feet above sea-level in sheltered situations. Experience has shown, however, that commercial growing of wattle on any scale is economically practicable only at altitudes between 2,000 and 4,500 feet above sea-level. At altitudes lower than 2,000 feet, particularly near the coast, mild winter conditions permit most

of the insect pests of wattle to produce more than one generation during each year and the resultant cumulative damage to the trees tends to reduce yields below an economic level. At altitudes above 4,500 feet, on the other hand, extremely cold winter conditions tend to stunt the growth of the trees, and losses due to frost, as well as damage caused by cold winds, may be considerable.

Slope and Aspect.

Cultural operations and the extraction of timber and bark are easier to carry out and the risk of soil loss due to sheet erosion is less on level or gently-sloping than on steeply-sloping land. In most of the main wattle growing areas, however, all the less steeply-sloping land is either already under wattle or is devoted to various other agricultural uses, and new afforestation must usually take place on otherwise suitable land which is too steep for arable purposes. If such land can be ploughed, it can be afforested to wattle without becoming eroded, provided suitable methods are adopted, and, although costs of establishment and maintenance may be slightly higher than on less difficult land, plantations on steep slopes may be expected to yield a sound economic return.

Otherwise suitable sites which are too steeply-sloping or too rocky to be ploughed may be afforested by hand cultivation of narrow strips along the contour for use as planting lines. The undisturbed grass between the planted strips must be hoed out in the spring following planting, however, if stagnation of the young trees due to root competition with the grass is to be avoided. Plantations established by means of strip cultivation will usually give poor yields in the first cycle, owing mainly to lack of proper tilth inseparable from this type of cultivation, but general site improvement resulting from the first crop will normally ensure economically satisfactory yields in subsequent cycles.

Aspect is also an important factor in establishing wattle plantations which should be confined, where possible, to aspects ranging from north-eastern to south-western, on which soil moisture conditions are usually more favourable. Where sites on western to northern aspects lie adjacent to higher escarpments and so benefit by the higher rainfall precipitated thereon, they may be afforested with good prospects of success, but generally the heat and dryness on such aspects militates against thrifty growth of black wattle planted on them.

Rainfall Requirements.

Black wattle will grow singly or in narrow belts in areas with annual rainfall as low as 25 inches, but when grown in plantation form, this species tends to suffer from drought under an annual rainfall of less than 30 inches. A study of South African rainfall records shows that considerable fluctuations in annual rainfall occur within the summer rainfall zone and that years of deficient precipitation, during which the rainfall may be as much as 8 inches below average, tend to recur at fairly frequent intervals. In view of this fact, it is recommended that areas in which the annual average rainfall is less than 35 inches should be avoided in commercial afforestation with wattle.

A further reason for avoiding areas of low rainfall when establishing wattle plantations is that such areas usually adjoin dry thornveld country, which is the natural habitat of the wattle bagworm and other insect pests of wattle, and they are usually the first areas to be invaded when the local population of such pests begins to increase. The normally unthrifty growth of wattle under conditions of marginal rainfall renders such plantations less able to withstand severe defoliation by insects, and losses resulting from insect attack in such areas may be considerable. Moreover, such areas of unthrifty wattle adjoining the thornveld infestation centres of wattle pests serve rather to increase the area of such infestation centres, thereby facilitating the spread of insects to plantations on more favourable sites and rendering control by insecticidal treatment of the infestation centres more difficult.

It would appear from test analyses that bark grown in areas of relatively low rainfall (35 to 40 inches) tends to contain a higher percentage of tannin than bark grown in areas where the average annual rainfall exceeds 40 inches. Gross yields of bark, however, are usually greater the higher the rainfall under which the trees are grown, and it is

probable that this yield increase will more than outweigh the reduced tannin content, so that gross yields of tannin per acre will vary directly with rainfall. In general, therefore, it may be taken that the higher the local rainfall, the more profitable commercial growing of wattle is likely to be in a given area, provided that soil and temperature conditions are also suitable.

Temperature Requirements and Other Climatic Factors.

Black wattle will thrive under fairly high day temperatures, but is rather sensitive to cold, whether in the form of frost or of cold winds. In selecting land for afforestation, therefore, areas known to be frosty should be avoided and caution should be exercised in planting areas at altitudes above 4,000 feet which are exposed to very cold winds in winter.

Wattle should not be planted in so-called " hail-belt " areas, which are known to be subject to severe hailstorms practically every summer. This species is slow to recover after damage by hail, and the bark may be so injured by a single severe hailstorm, while the plantation is still young, as to cause degrade at maturity. It is, of course, almost impossible to avoid hail damage entirely, since hailstorms are a normal phenomenon in the summer-rainfall zone during the summer months, but light hail causes very little damage as a rule, and the occasional severe freak storm, in an area where severe hail is not common, must be accepted as a normal risk.

Soil Requirements.

The soils of the main wattle-growing areas are derived from shales, sandstones, granite, dolerite, and tillite, and vary in texture from sands to clay loams, all more or less deficient in humus. The growth of black wattle is satisfactory on any of these soil types, provided the soil is reasonably deep and well-drained. The highest yields of bark are normally obtained from plantations growing on deep soils derived from dolerite or from Table Mountain Sandstone. Plantations on soils of shale origin give fair yields, provided that these soils are sufficiently deep and that the underlying shale is well fissured, but tend to suffer from drought during the dry season where these conditions do not exist. The poorest growth of wattle is found on shallow soils with a high percentage of quartzitic grit, derived from the Old Granite and Primitive Systems ; such soils are found in parts of Southern Natal, Zululand, and the South-eastern Transvaal.

Ironstone pans or layers of nodular ferruginous concretions (*pudding stone, ouklip, or mgubane*) often occur in soils derived from the Old Granite or Table Mountain Sandstone and, where such layers lie near the surface, they are detrimental to the growth of wattle and should be avoided when establishing plantations. Similarly, unweathered dolerite dykes or sills forming layers of sheet rock near the surface should be avoided when afforesting with wattle. The black, peaty soils (*dudus*) which are found sometimes on high plateaux in the Natal Midlands and the foothills of the Drakensberg are often underlain by sheet rock of this type and tend to become water-logged after rain and to dry out equally rapidly. Such soils should, therefore, be afforested only when the digging of test pits has proved them to be sufficiently deep.

On sites having a thin layer of surface soil overlying a hard compact subsoil, such as are found where severe sheet erosion has taken place on old agricultural lands or over-grazed veld, growth stagnation tends to occur in the early life of the crop if the subsoil is brought up to the surface by deep ploughing.

Where soils are very sandy and super-drained, a rather higher average annual rainfall than the 35 inches referred to above should be taken as a minimum requirement for successful commercial cultivation of wattle.

Points to Consider in Selecting a Property for Wattle Growing.

While discussing the environmental requirements for successful commercial wattle growing, it may not be out of place to mention certain additional points which should be considered by any prospective wattle grower before purchasing a property.

(*a*) *Size.*

Two major considerations govern the optimum size for an individual wattle propo-

sition ; firstly, the area which will produce a given minimum nett income, allowing for possible fluctuations in the bark and timber markets, and secondly, the maximum area which can be managed efficiently by one man. Assuming that a green bark yield averaging 7 tons per acre over a 10-year cycle can be obtained, a property comprising 500 acres of wattles in equal-sized blocks of all ages from 1 to 10 years should produce a nett income of £1,000 per annum, even when the average green bark price is as low as £5 per ton at factory. On the other hand, bearing in mind that fifty per cent. of the total area of a normal wattle plantation managed on a 10-year cycle requires supervisory attention annually, 1,500 acres is about the maximum area which one man can supervise efficiently.

On properties where wattle growing forms a part of a mixed farming business, the area under wattle should not be greater than the area under arable crops and should in any case not exceed 200 acres for efficient management by one man.

(*b*) *Situation in Relation to Markets.*

Transport of bulky produce such as bark and timber is naturally expensive, and reasonable proximity to rail is an important consideration in selecting a wattle property. An average distance of 12 miles from rail may be regarded as an economic maximum for petrol-driven transport and 25 miles for diesel-powered transport under normal conditions. Within a certain road distance from an extract factory, however, it may be more economic to deliver bark directly by road transport to the factory than to use the railway.

Properties within a maximum distance of 150 miles by rail from an extract factory can normally market green bark economically, but at greater distances than this, dry bark production is advisable.

(*c*) *Labour Supply.*

Proximity to a large supply of native labour, such as a location or native reserve, is an advantage, but a certain basic minimum of resident labour, sufficient to cope with a plantation fire at short notice, is essential. To determine the number of labourers required to run a wattle estate efficiently, an allowance of one labourer to every twenty acres of the total planted area should be made.

THE ESTABLISHMENT AND RE-ESTABLISHMENT OF WATTLE PLANTATIONS

By S. P. SHERRY

The initial afforestation of natural grassland or old agricultural land with wattle and the regeneration or re-establishment of a new crop of wattle on old wattle land present rather different problems and are therefore discussed separately below.

Soil Preparation.

(*a*) *Afforestation with Wattle on New Land.*

Virgin grassland should be ploughed in autumn when the natural grasses have begun to die back, but this grass should not be burned before ploughing unless the growth is so dense as to make ploughing otherwise impossible. The ploughing-in of the grass cover will add materially to the normally low organic content of the surface soil, thus helping to increase its water-holding capacity and tending to reduce run-off and soil loss after heavy rain.

In afforesting natural grassland with wattle, it is essential first to break up the soil thoroughly in order to kill off the perennial grasses, since wattle, unlike pine, usually does not thrive if planted in spots or ploughed strips in otherwise undisturbed grassveld. For this reason, care must be taken in ploughing to avoid leaving unploughed strips. Thorough hand-preparation by means of hoes or pick-mattocks is almost as effective as ploughing, but is too expensive to be an economic proposition except in the case of small islands of rocky ground in areas which are mainly ploughable. If it is desired to afforest land which is very rocky or too steep to be ploughed, even with ox-drawn ploughs, hand-preparation must be employed. In such cases, strips about 3 feet in width may be hand-hoed on the contour, the grass between them being left undisturbed. A seed-bed about 1 foot in width is then prepared down the centre of each cleared strip by breaking up the soil thoroughly to a depth of about 4 inches with a heavy hoe or mattock, and the seed is sown in this bed in March or April. When the trees on the cleared strips have reached a height of about 2 feet, usually in the following spring, the intervening grassed strips should be hoed clean. If this is not done, the seedlings are likely to receive a severe check to growth when the lateral spread of their root systems brings them into competition with the undisturbed grass. In extreme cases, growth virtually ceases and a full year may elapse before a normal growth rate is resumed. It would obviously be better to hoe the land clean in the first place, but the above method is suggested in order to spread the cost of this necessarily expensive hand operation over two seasons and to economize on labour. It must be realized, of course, that the growth of trees on land which has been merely hoed clean and not broken up to some depth will not be as vigorous as on land which has been ploughed or well prepared with mattocks. Yields of bark in the first cycle on land which has been afforested in this way will probably be lower than on land which has been well prepared, but there is no reason why normal yields should not be obtained from such stands in the second and subsequent cycles.

When the land has been ploughed in autumn and fallowed over the winter, it may or may not be necessary to break it down further by disc-harrowing in the spring. In sandy soils, the plough-sods will often crumble sufficiently to permit the use of a planter without further cultivation, but in heavier soils, discing is usually necessary. If the

land is sloping, it is advisable to disc-harrow only along the future tree lines, on the contour, leaving narrow strips of unbroken plough-sods between the rows. Experience has shown that even on very steeply sloping land, these unharrowed strips are most effective in preventing surface soil loss during heavy rains. An alternative to harrowing is to prepare narrow seedbeds with hoes along the proposed tree lines ; this method is preferable to disc-harrowing on sites where there is considerable risk of erosion.

In the afforestation of old agricultural lands to wattle, the dense growth of weeds which normally appears on such land may necessitate several weeding operations during the first season to prevent suppression of the young trees. In order to avoid expensive hand-hoeing in such cases, it is advisable to plough the land after the first rains in spring and then to destroy the resultant crop of weeds by disc-harrowing before these come into flower. If weeds reappear, a second disc-harrowing may be necessary before sowing the wattle. This should be done in March, and, in most cases, only one light hoeing will then be required before winter to kill late germinating weeds.

(*b*) *Re-establishment of Wattle Plantations after Felling.*

There are two schools of thought in regard to the best technique for disposal of the brushwood which is left on the ground after a crop of wattle is felled preparatory to establishing the new crop. One favours the stacking of all brushwood in regular piles on the contour and allowing it to rot down, the other recommends the disposal of some or all of the brushwood by piling and burning it. No quantitative data exist to prove which of these two methods will give the better result on a long-term basis, but experiments have been started which are expected to provide this information in due course. In the meantime, it is felt that the policy of non-burning of brushwood is the safer one to pursue for a number of reasons, which are discussed below.

Plantations over a large proportion of the wattle growing area are on sloping land, and this fact, coupled with the fact that most good wattle soils are highly erodible, intensifies the risk of surface soil loss during the period in which the soil is exposed by the felling of one crop, and before it can be protected by the crowns of the next. For this reason alone, the retention of contoured piles of brushwood to provide a barrier against soil erosion would appear to be justified. Additional reasons in favour of non-burning of brushwood are that soil moisture is conserved in the vicinity of the rotting piles, and that fungal enemies of the bagworm are enabled to survive from cycle to cycle in the old brushwood, thus helping to maintain biological control of this pest. The following recommendations are made, therefore, on the assumption that brushwood will not be burnt in re-establishing the new crop.

At the end of the autumn preceding the felling of a crop of wattle, it is well worth while hoeing out any perennial grasses or weeds growing under the old crop, so as to have a clean floor for re-establishing the new crop. By carrying out this operation before the winter, any weed or wattle seed which is stimulated to germinate through the disturbance of the surface soil by hoeing will die off as a result of shading and root competition during the cold, dry, winter period. At this time also, any large fallen branches, windfalls, dead trees, and other large debris should be collected and laid in rows at intervals, on the contour, to mark the lines on which the brushwood from the felled crop is to be stacked. If there is insufficient debris for this purpose, the sites for future brushwood lines should be marked with wooden stakes driven into the ground at intervals. The distance apart for brushpiles will vary according to the crown density of the crop and may range from 20 to 40 yards. Allowance should be made for piles 6 to 7 feet in height over a maximum width of 12 feet ; it is important that piles should be as high as possible and that they should be tightly packed to prevent grass, weeds, and wattles from germinating within them.

In re-establishing a crop of wattle on land where brushwood has not been burnt in previous cycles, all that need be done to encourage rapid and even germination is to prepare narrow seedbeds next to the existing tree rows. This is done by chipping through the dry leaf litter with a hoe, to a width of about 9 inches, in order to incorporate the litter with the surface soil. Care should be taken to disturb the mat of litter between these seedbeds as little as possible, to avoid stimulating germination between the rows. In

plantations where no brushwood has been burnt for two or three cycles, adequate germination will normally be obtained without hoeing seedbeds, but it is usually worth while carrying out this operation, just before felling the crop, in order to secure quick and regular germination.

Where brushwood has been burnt in previous cycles, it is inadvisable to rely on natural regeneration in re-establishment, although, in areas of high rainfall, an adequate stand will sometimes be obtained without sowing on previously burnt sites. On the other hand, on hot, dry sites, and where the surface soil is hard and compact, it may be necessary to sow two or three times before a satisfactory stand is obtained. Whatever the conditions, however, the cost of preparing seed-beds and of sowing is usually more than repaid by the saving in time and the even nature of the stand which is obtained by this means, as opposed to waiting for natural regeneration to take place.

The method of regeneration known as strip-burning is employed by some growers. This consists in raking up a narrow heap of leaf litter along the proposed tree rows and burning it to stimulate germination of natural seed lying on and in the surface soil. The method is effective in stimulating germination on sites where burning has previously been practised, but has certain disadvantages. Very densely-stocked strips of seedlings are produced, and, if early suppression is to be avoided, these must be spaced much earlier than is necessary in sown lines. Unless strip-burning is carried out under careful supervision and when weather conditions are suitable, there is a risk of fire spreading from the litter to the stacked brushpiles. Finally, on hot, dry sites, where surface soils are hard, compacted, and deficient in humus and, therefore, most difficult to re-establish, there is often so little litter that the surface must be literally scraped bare to obtain sufficient material for a successful strip-burn. The effect of this is to deprive the soil of such organic matter as has been accumulated during the preceding cycle, which can hardly improve site conditions.

The fact that wattle timber must be more or less air-dry before it can be sold as firewood or mining timber makes it difficult to avoid delay in regenerating wattle stands after felling. Stripping is carried out during the rainy season, and the felled timber must normally lie at least three months in the plantation before it is dry enough to be saleable. During this period, it is virtually impossible to weed or space the young trees because, after felling, the timber is left lying haphazardly all over the plantation floor. Hence, if natural germination is good, the seedlings tend to suffer from delay in first spacing and weeding, whereas, in areas where sowing is necessary, a heavy growth of grass may be able to develop before the ground can be cleared of timber and the seed sown.

A method of dealing with the timber, which permits spacing and weeding operations to be carried out as soon as they become necessary, has been devised and proved successful in practice in plantations where all timber is sold as firewood. Under this system, stripping is carried on for the first five days in each week, but on the sixth day, all stripping labourers are set to chop the timber felled during the preceding five days into 15-foot lengths, and to move these between and parallel to the prepared seedbeds. The timber is easily chopped into lengths while green, and may be left to lie as long as is necessary for it to dry out without interfering with early spacing and weeding operations in the new crop. Reasonable care must, of course, be exercised when extracting the dry timber to avoid unnecessary damage to the young seedlings by trampling.

Where it is proposed to use this method, seedbeds should be prepared in advance of felling as described above. If sowing is considered necessary, the seedbeds over as large an acreage as can be felled and stripped in a week by the labour supply available should be sown just prior to stripping. The seed will normally germinate in about ten days and the seedlings will not be damaged by trampling, since the stripping labourers will have completed their work and the timber will have been cut and laid before germination can take place.

It is doubtful whether this method of timber disposal will be practicable on estates where mining timber is exploited. If mine poles are selected and sawn while the timber is still green, a good deal of wastage due to end-cracking may occur during the drying period. On the other hand, the risk of damage to the young trees will be considerable

if poles are sawn after the timber has dried out. If sawn firewood is produced as well, however, it may be practicable to extract the dry timber in long lengths, transport it to a central depot and there cut selected mine poles and convert all waste into sawn firewood. Even if such an arrangement proves a little more expensive than methods in current use, it will probably be found to be economically advantageous in the long run, because of the time saved in securing re-establishment.

Treatment of Seed.

Wattle seed has a very hard coat, and must be specially treated before sowing to ensure reasonably rapid and even germination. The recommended method of treatment is to pour water at 95°C. over the seed, which is then left to soak for 12 hours in the water as it cools off. The simplest way to achieve this result in practice is to bring water to the boil in a container of convenient size, and then to remove the container from the fire and allow it to stand for about 5 minutes before putting the seed in. After 12 hours soaking, the water should be poured off and the seed washed thoroughly in two or three changes of fresh, cold water to remove the mucilage which is exuded as a result of the hot water treatment. The washed seed must then be spread on sacking or canvas in the shade to dry. When thoroughly dry, it may be re-bagged and, if stored in a dry place, may be kept without deterioration for at least a year before sowing. In any case, it is advisable to store the freshly-treated seed for about 3 weeks before sowing in order to secure optimum germination.

Sowing.

Sowing may be done at any time during the spring and summer period, after good rains have fallen, but the best results are usually obtained from sowings during the period from January to March, when rains are normally most regular. In areas where light frosts may be expected during the winter, sowings in April or early May are preferable. Seedlings arising from such late sowings are still small enough during the winter to escape damage if frosts occur, whereas larger seedlings from spring or summer sowings may have their leading shoots killed back by frost.

Wattle seed may be sown by means of a maize planter fitted with a special plate having six $\frac{3}{8}$-inch holes, or by hand from a planting tin. The latter is best made from a tin with a tight pressed-in lid, such as a syrup tin. The bottom of the tin is cut out cleanly and in its place a piece of thin sheet metal, bent into the shape of an inverted cone, is soldered. The closed end of this funnel is then filed away until it will allow a thin, steady trickle of seed to run out. The tin is wired firmly to one end of a stick about 30 inches long, so that it can be conveniently held and shaken with the funnel just above the surface of the soil.

The aim in sowing, whether by means of a tin or a planter, should be to obtain a single, continuous line of seed, with individual seeds falling about 1 inch apart in the drill. Sowing seed in spots is not recommended, because an undesirable gap will be left in the row if two adjacent spots fail, and also because of the difficulty of controlling the amount of seed sown per spot. Under normal conditions, with line sowing, two pounds of seed will sow one acre. On hot, dry sites, on sandy soils, and on old agricultural lands, where cutworm may attack the young seedlings, at least double this quantity should be used.

Wattle seed should be sown to a depth of about 2 inches, and the soil should be firmed down over the seed after sowing, if possible. On hot, dry sites and on sandy soils a sowing depth of 3 inches should be used. This enables the seedling root to reach a greater depth before the young leaves appear above the surface and begin to draw upon soil moisture, and therefore improves the seedling's chances of survival under dry conditions.

Row Espacement.

A difference of opinion exists among growers regarding the optimum row espacement for wattle, and espacements ranging from 6 to 12 feet are advocated in different quarters. The main argument in favour of wide row espacements lies in the fact that

they permit the use of mechanical implements for controlling weed growth between the rows. Except in districts where labour is in very short supply, however, it is doubtful whether mechanical cultivation is economically justified in wattle plantations. Wattle has a strongly developed lateral root system in which many roots lie in the upper 2 inches of the soil, and it is difficult to remove weed growth by cultivating without damaging these surface roots to some extent. Since it is known that wattle can be infected by wood-rotting fungi through wounds, either on the stem or on the larger lateral roots, any damage to roots must increase the risk of losses in yield due to disease. In addition, the considerable soil disturbance resulting from mechanical cultivation creates ideal conditions for the germination of wattle seed in the soil. Thus it is usually necessary to carry out a second cultural operation at an interval after each weeding operation, in order to kill off wattle regrowth, thereby further increasing the risk of root injury to the crop trees.

Narrow row espacements permit the crowns of trees in adjacent rows to meet, and so kill off weed growth between the rows by shading, at an earlier age than is possible when rows are further apart. Thus, in most cases, two hand-weeding operations are sufficient to control weed growth until the trees are tall enough to overtop the weeds. Moreover, the relatively small amount of soil disturbance resulting from hoeing seldom encourages such dense wattle regrowth as does mechanical cultivation. A further advantage of narrow row espacements is that they allow a greater degree of selection in thinning to a given density than do wide rows. For these reasons, growers are advised to use a 6-foot row espacement when establishing new plantations in all districts where there is no marked and chronic shortage of native labour.

A REVISED VALUATION OF WATTLE PLANTATIONS FOR INSURANCE

By S. P. SHERRY

Prices of wattle bark and timber have increased considerably during the past two years and it has, therefore, become necessary to revise the valuation tables for wattle plantations (Sherry, 1950). The revised tables have been computed on the basis of current average growing costs and average bark and timber prices of £13 6s. 6d. per long ton and £1 7s. 6d. per short ton respectively. A yield of 7·5 tons of green bark and 30 tons of timber per acre at 10 years has been assumed.

(*a*) Wattle on Land Valued at £10 Per Acre.

Age of trees in years	Computed value/acre	Corrected value/acre	Suggested insurance value/acre
	£ s. d.	£ s. d.	£ s. d.
1	7 8 0	7 8 0	7 10 0
2	13 8 9	13 8 9	13 10 0
3	19 16 0	19 16 0	19 15 0
4	26 6 0	26 6 0	26 5 0
5	33 13 0	33 13 0	33 15 0
6	42 6 0	42 6 0	42 5 0
7	52 9 5	53 10 0*	53 10 0
8	64 8 5	68 0 0*	68 0 0
9	78 9 2	82 18 0*	83 0 0
10	95 0 0	95 0 0*	95 0 0

(*b*) Wattle on Land Valued at £15 Per Acre.

Age of trees in years	Computed value/acre	Corrected value/acre	Suggested insurance value/acre
	£ s. d.	£ s. d.	£ s. d.
1	7 18 0	7 18 0	8 0 0
2	14 8 0	14 8 0	14 10 0
3	21 3 7	21 3 7	21 5 0
4	27 19 5	27 19 5	28 0 0
5	35 11 0	35 11 0	35 10 0
6	44 6 7	44 6 7	44 5 0
7	54 8 9	56 0 0*	56 0 0
8	66 1 2	70 0 0*	70 0 0
9	79 10 2	83 16 0*	83 15 0
10	95 0 0	95 0 0*	95 0 0

* These data have been adjusted to conform with a normal increment curve.

The values in the early years may seem rather high, but it must be remembered that, although trees in immature classes may have no market value, they have a potential value in terms of compounded costs and of compensation for time lost in replacing them should they be destroyed.

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This is an historical account of the origins and development of the South African wattle industry.

Copies of most of the above publications may be obtained on application to the Institute. In addition, a reprint of a series of "Notes on Research and Recommendations in Relation to Wattle Production," originally published in *The Natal Witness* Weekly Supplement *The Farmer*, is available on request.

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